The Mining Journal
AND COMMERCIAL GAZETTE.

SUPPLEMENT---XX.

REVIEWS.

A Treatise on the Strength of Timber, Cast Iron, Malleable Iron, and other Materials; with Rules for Application in Architecture, Construction of Suspension Bridges, Railways, &c., with an Appendix, on the Power of Locomotive Engines, and the Effect of Inclined Planes and Gradients, &c. By PETER BARLOW, F.R.S., &c. &c. Weale. London, 1837.

About twenty years have elapsed since the first publication of Professor Barlow's "Essay on the Strength and Stress of Timber," during which period it has passed through several editions, and has ever been esteemed as one of the most valuable works on this important subject. During the period referred to, the science of engineering and the art of construction have undergone considerable changes, numerous applications of materials, before scarcely known, have been introduced—operations of vast magnitude have been carried on, of a nature differing greatly from any that had preceded them—and the attention of scientific men has, therefore, been called in a much greater degree than formerly, to those practical experiments, and those theoretical investigations, which are connected with the strength of materials and the circumstances of their application.

A work embracing all the results which have been thus obtained, and placing the subject on the most secure basis for the guidance of the architect and engineer, has thus become a desideratum of much importance to the practical man, who, in the midst of multiplied and harassing avocations, can often scarcely find leisure to compare and to decide between opposite results, much less to make experiments and calculations for his own use. To produce a work of this kind, however, it was necessary either to render it entirely original, or to completely re-model any thing which had been previously published—in either case a task of great labour, and demanding extensive knowledge, both practical and mathematical, of the subject to be treated upon.

This task has been ably accomplished in the work before us; nor could it have fallen into better hands than those of Professor Barlow, whose long devotion to experimental investigations of the subject, aided by the peculiar facilities afforded by his situation and connexion with Government, must be well known, while he possesses the further advantage of bringing mathematical abilities of no common order, to bear upon the matter before him—a circumstance conferring a peculiar value on his labours.

The strength of materials and the principles of construction, are subjects of such great and obvious importance, that few observations, as regards their utility, will suffice. To the architect, the engineer, the machinist, in fact to all who practice the useful arts, the mechanical properties of the various kinds of matter which they employ, is a matter of the first consideration. The cohesion, density, contraction, expansion, and many other properties of different materials, are the circumstances which adapt them to particular uses—which limit their application, and which determine the form and mass required under all the varying circumstances which continually occur in practice, as well as many of the minor details of construction.

Of all these various properties, an extremely useful approximate knowledge has long since been obtained by practice only. Guided by practice and experience alone, much has been done, not only as regards the more common constructions required for ordinary purposes, but even in the execution of works of a higher order and of considerable magnitude. We do not hesitate, however, in saying that, in most cases, what has been *well* done by practice only, might, with the aid of science, have been done still *better*—and that science offers both a shorter and a surer road to correct results, than that which can be obtained by the repeated and often abortive attempts of practice only.

To employ a greater mass of material than is actually necessary to obtain the requisite degree of strength, is not only a waste of the material itself, but instead of giving strength to the fabric, in reality is a source of weakness. An injurious result of a twofold nature is thus produced; and in works of great magnitude, where both the first expense of materials and the after expenditure for repairs is considerable, it is an object of the greatest importance that the original construction should be regulated on the soundest and most correct principles.

Our knowledge of the strength of materials, both experimental and theoretical, has undergone great and rapid improvement within the last half century—chiefly, indeed, during the latter part of the time—and the effects of this knowledge upon the principles of construction, are apparent in most of the great works which have been executed of late years. As instances of this, we need not go beyond the Metropolis for striking examples—the elliptical form of arches which was applied with so much caution to the building of Blackfriars Bridge, only seventy or eighty years ago, has now been carried to a much greater and more beneficial extent, as may be seen in the flat and graceful arches of the new London Bridge. The width of the Thames at London Bridge is nearly the same as at Blackfriars; yet the greater flatness of the ellipse, renders only five arches necessary at the former place, while, at the latter, nine are required. We need hardly point out how great a saving of labour and materials is caused by this improved construction, while its advantages, in affording greater water-way, and exposing a much less surface to the destructive effects produced by the alternate action of the tides and the atmosphere, is equally obvious.

As regards the application of cast iron to works of great magnitude, both Southwark and Vauxhall bridges, the former especially, offer fine examples, not only of the improved state of the manufacture of this metal, but of our knowledge of its strength and capabilities, and the boldness of construction to which this knowledge has given rise. The application of wrought iron has, on the same principle, been no less widely extended, as may be seen in the fine suspension bridge at Hammersmith, and still better in its noble prototype, the suspension bridge across the Menai Strait. The substitution of wrought iron rails for those of cast iron, and the change, both in form and dimensions, which the rails have consequently undergone, are another example of our rapid advance in the important branch of knowledge under consideration, and the present wide extension of the railway system, renders every information on this point of the highest value.

The nature and arrangement of Professor Barlow's work, cannot be better described than in his own words, and on this subject we therefore, extract the following passages from the introductory portion:—

"The arrangement which it has now been thought proper to adopt may be thus stated: the first subject treated of, is the strength of direct cohesion of the fibres of timber, with an account of the experiments of Musschenbroeck, Du Hamel, Emerson, and others; and lastly, of those made by the author, with a description of the apparatus by which the results were obtained.

"The next division treats of the mechanism of the transverse strain to which timber and other materials are exposed when loaded in any part of their length, and the mechanical action of the fibres to resist this strain. We then investigate theoretically the laws of deflections under all the varieties of position and fixing, to which timber and iron are subjected in architectural and other constructions. Having thus examined theoretically the nature of the several strains and the consequent deflections, we proceed to a detail of various experiments by Buffon, Girard, Beaufoy, &c., on the transverse strength of timber; and lastly, the original experiments of the author, which laid the foundation of the first edition, and on which is founded the Table of Data adopted in the subsequent part of this division of the work. Another section is employed in the detail of experiments on bent timber, as used in shipbuilding—on the effect of boiling and steaming timber; experiments by Girard on vertical pressure, and a series of illustrative problems and examples. A short chapter follows on the strength of cement and building materials, as stone, brick, &c., and on the subject of revetment walls.

"The next division treats on the direct strength of cast-iron and its application in the construction of hydrostatic presses; also on the direct strength of copper, brass, yellow metal, &c., from experiments made by Mr. Kingston on the testing machine in his Majesty's dock-yard at Woolwich; and others by Messrs. George Rennie, Tredgold, and Duleau.

"The following chapter treats on the transverse strength and deflection of cast-iron beams under a great diversity of forms, principally from a highly-interesting and valuable paper by Eaton Hodgkinson, Esq., in Volume V. of the Manchester Memoirs. We come now to the subject of malleable iron; and as the experiments on this material were principally made on the testing machine in his Majesty's dock-yard, Woolwich, it was thought that an accurate drawing and description of this machine would be acceptable to the reader; two new plates have been therefore introduced, illustrating, its entire construction and operation.

"A detail of experiments is then given on the strength of direct cohesion of iron bars and bolts, the testing strengths of the different descriptions of iron cables used in the British navy. Mr. Telford's experiments on iron wires; and lastly, a Table by Davies Gilbert, Esq., for the calculation of the several particulars connected with the construction of suspension bridges.

"The next subject of investigation is the application of malleable iron to the purposes of railway bars, being the substance of two Reports by the author, addressed to the directors of the London and Birmingham Railway Company, with the addition of several subsequent experiments on railway bars of various forms and dimensions, and of miscellaneous experiments on the effect of locomotive engines and trains on the bars of the Liverpool and Manchester line.

These form the subject of the principal matters treated of in the body of the work, but an Appendix is added, on the practical action of locomotive engines, and on the effect of inclined planes and gradients, with a view to the comparison of the mechanical advantages and disadvantages of rival lines of railway."

To enter minutely into the contents of a work chiefly occupied by mathematical reasoning, analytical investigations, and tabular results, would be tedious and uninstructive; we shall, therefore, proceed to make such few extracts as may conveniently be separated from the other matter, and contain information of any general interest. Of this nature is the following, referring to the work of M. Du Hamel "Sur l'Exploitation des Bois," Professor Barlow observes—

"From a great number of experiments and observations on the latter point, the author concludes that the best oaks, elms, and other great trees, are the produce of good lands, rather of a dry than of a moist quality; they have a fine and clear bark; the sap is thinner in proportion to the diameter of the trunk; the ligneous layers are less thick, but are more adherent the one to the other, and have a greater uniformity of texture, than trees which grow in moister situations. The grain of these woods is fine and compact; and when they are examined with a good glass, their pores are observed to be filled with a species of varnish, or glutinous matter, strongly adherent, which gives them commonly a pale yellow colour, by which they may be distinguished from trees that are the growth of a different soil.

"Also, in consequence of the closeness of their pores, they are more dense and heavy, become extremely hard, and resist the attack of worms.

"The specific gravity of a tree growing in such soil as that above described, is to that of a similar tree in a wet marshy situation, frequently as 7 to 5; and the weights which a similar beam will support without breaking, in the two cases, are in about the ratio of 5 to 4.

"May not this account for the superior quality of the Sussex oak? which I am informed by Mr. Hookey, timber-master in the Deptford Dock-yard, he has always found to be the best for strength and durability; that the next in quality is that which grows in the south-west parts of Kent, and the north-east parts of Hampshire."

Passing over a large portion of the work devoted to an able analysis of the strength and stress of timber and various metals, especially cast iron, the direct cohesive power of which the author considers to have been much over-rated by Mr. Tredgold, but certainly to exceed ten tons in a bar one inch square, we have the following important observations on the strength of that metal: "Cast iron may, therefore, be considered to have its elasticity destroyed with about one-third the weight that will produce fracture; it ought not, therefore to be loaded in permanent constructions to more than this amount."

Proceeding to the strength of malleable iron, we have the following introductory remarks:—

"It is only since the commencement of the present century that malleable iron has been employed in situations which rendered it desirable to know with certainty its strength under different circumstances. With the exception of anchors and chains, malleable iron was seldom employed to resist by itself very great strains, its general application having been to connect and tie together different parts of a structure under circumstances which rendered it difficult, and not essentially necessary, to know with accuracy, its ultimate force of resistance: all that is requisite in such cases is, that the iron shall exceed the strength of the other parts, and as the quantity thus employed in any case was inconsiderable, it was of little importance if more iron than was really necessary was used, and which, therefore, was commonly done and its actual strength disregarded. But since the time alluded to, malleable iron has been introduced for several important purposes, in which it is employed by itself to resist enormous strains, as in the case of ships' cables, suspension bridges, and railway bars; it is, therefore, of the greatest importance that we should be able, from a knowledge of its actual strength, to proportion the several parts, so that while we ensure perfect safety on the one hand, we may not on the other unnecessarily employ more of the material than is requisite, for all the weight thus introduced beyond what safety requires is always unnecessary, and frequently injurious."

Mr. Barlow's experiments on the cohesive power of malleable iron appear to agree pretty nearly with the results formerly obtained—the direct cohesion of bar one inch square, varying from twenty-nine to thirty-one tons, but only in one experiment (with Staffordshire iron) reaching the latter amount. The strength of malleable iron, with its laws of tension and deflection are admirably treated upon, we extract the following passage on the wear of rails:—

"That the rail is deteriorated by exposure and wear is undoubtedly true, although, perhaps, the amount is not yet well ascertained. Amongst the papers submitted to Messrs. Rastrick and Wood, with whom I was associated, we found it estimated, at the rate of one-sixth of a pound per yard per annum; but I have since seen it stated, in a letter from Mr. Dixon to Mr. Bidder, at one-tenth of a pound per yard per annum. This was determined by taking up three rails, having them well cleaned and weighed, and then putting them in their places, and afterwards washing and re-weighing them at the end of a twelvemonth, when two of them were found to have lost half a pound in weight for the five yards length, and the third three-quarters of a pound, which last was taken up from a particular situation where it was more exposed to friction; but even this does not prove that the whole loss of weight is in the upper face of the rail; and if it did, it would be, as I have before observed, a stronger reason for not turning the rail; and, on the other hand, should the waste not be on the upper surface, the provision alluded to is unnecessary. Mr. Rastrick informs me, that even the small fins left at the meeting of the rolls are still quite distinctly seen on the face of the upper table. And Mr, Stevenson states, that the marks of the tools left in turning the flanches of the wheels are seldom obliterated; which proves, at all events, that there is no side wear.

"Mr. George Bidder, who attributes all the waste to the wear on the upper surface, estimates the annual reduction at one-ninetieth part of an inch; in which case the rails would not last more than thirty years before they would require to be replaced. And it then becomes a question, whether in point of economy, it would not be better to lay an additional third of an inch upon the upper table, which would, by this reckoning, make the rail last sixty years. This increase of one-third of an inch would call for an additional expense, to the amount of about seven and a half per cent. on the present cost; and this seven and a half per cent., at compound interest, would amount to about thirty per cent. in thirty years. If, therefore, a charge of thirty per cent. at the end of thirty years, would meet the amount of re-manufacture, and supply the waste, the two accounts would be about balanced. In this case, I must consider the latter as preferable. 1st. Because the other plan would increase the weight of the bar, and the difficulty of the manufacture, and probably diminish its soundness. 2nd. Because thirty years' experience may introduce improvements, of which, at the end of that period, it would be desirable to take advantage. And, lastly, because I do not (judging from the opinion of different practical men) think it has yet been clearly determined what part of the waste is due to wear on the upper face."

The following extract from a report, addressed to the directors of the London and Birmingham Railway Company, will give the author's conclusions with regard to the mode of fixing rails, and the circumstances of contraction and expansion which require consideration in determining this point:—

"'The accompanying paper contains the details of the experiments I have made, in conformity with the resolution of the general meeting of the proprietors of the London and Birmingham Railway Company, held at Birmingham, on the 13th of February, 1835, and I am in hopes several important data and rules have been thus elicited. These will be found in the paper referred to; but it may be convenient to state the results in this place, referring to the proper pages for the experiments and investigation on which they are founded.

"'It has been ascertained, page 319, that a malleable iron bar of any length is extended one-thousandth part of its length by a direct strain of a ton per inch on its sectional area; and that, when strained with ten tons per inch, or when stretched one-thousandth part of its length, its elasticity is injured, and the bar will not return to its original state.

"'Now, as the contraction of iron, between summer and winter, amounts to a two-thousandth part of its length, it follows, that the bars cannot be fixed permanently to the chairs and blocks, without great danger of drawing so much upon their strength, as materially to impair their efficiency for bearing a great passing load.

"'It follows also as a consequence, that if the rails and chairs must not be permanently fixed to each other by direct means, it ought not to be attempted by indirect means, viz., by cotters, keys, or wedges; for, either these will hold the rail to the chair, or they will not. If they do hold fast, they produce all the mischief which permanent fixing would occasion; and if they draw, then they do no good, although they may still do mischief. Whence I am led to conclude that the rails should have no greater attachment to the chairs than is sufficient for preserving them steady while the load is passing.'"

The work concludes by an investigation of various circumstances connected with the strength and form of rails, and numerous experiments made by Professor Barlow on this subject. The following summary contains the principal conclusions at which he has arrived:—

"I have in the course of the preceding pages replied to every point, which by the resolution already referred to, I was requested to examine and to report upon. In so doing I have thought it right to explain the several principles and experiments from which I have drawn my conclusions; and these being thus disconnected, it may be well to state them here collectively and isolated from other matter. In this form they will stand thus:—

"1st. I am of opinion, that as far as is consistent with the amount of the first outlay, it is desirable to increase the weight or section of the rails, and to decrease proportionally the number of bearing blocks.

"2d. That in cuttings and other places furnishing a good firm bearing, the present size of blocks is sufficient; viz., allowing for the intermediate blocks four feet, and for joint blocks five feet, while the bearing length does not exceed five feet; but that on embankments they will probably require to be proportionally increased in size. But I recommend this to be put to the test of actual experiment.

"3d. I am of opinion that the cost of maintenance will, in the former case, after a short time, be in proportion to the reduced number of blocks, but certainly not less.

"4th. I consider the double and equal flanched rail to be inferior, in strength and convenience of fixing, to that which is described and modified to suit different distances, in a preceding page.

"5th. I consider Mr. Sinclair's proposition for rendering the rail plain at its points of bearing, to be in every respect recommendable.

"6th. I am of opinion the form of chair, and method of fixing the rail in the chair, proposed by Mr. Stephenson, is as simple and efficient (adopting the plan of rolling of Mr. Sinclair) as can be desired.

"7th. Yielding, as I am always ready to do, to practical opinions, when they are found pretty generally to agree, I am disposed to think the present mode of fixing the chairs to the blocks, with a wooden plug and iron pin, is, from its simplicity and convenience, the most recommendable.

"Lastly. I am strongly convinced that no change or modification of form will produce any essential improvement, till greater uniformity be enforced in the figure and dimensions of the rails and chairs, and greater attention paid to the parallelism of the blocks, and to a proper adjustment of the distances of the ends of the rails from each other to allow for expansion and contraction."

The work contains a number of beautifully engraved plates, chiefly illustrative of the experiments detailed in it, and also an appendix, embracing theoretical investigations on the effect of the deflection of rails, inclined planes and gradients, &c. The name of Professor Barlow is in itself sufficient guarantee for the excellence of the work, of which our extracts will have afforded some idea

We would observe, in conclusion, that it ought to form part of the library of every architect, engineer, and machinist, and will to each of these professions prove a highly valuable acquisition.

Egypt as it is in 1837. By THOMAS WAGHORN, General Agent in Egypt for Steam Intercourse, *via* the Red Sea, between England, India, Ceylon, China, &c. Smith and Elder. London, 1837.

In the pamphlet before us, Mr. Waghorn appears as the avowed advocate of Egypt, and the defender of her rights against the extortionate demands and overbearing insolence of the fallen power of Turkey. The subject on which he treats would be of too political a nature for our columns, were it not closely connected with steam communication to India—perhaps one of the most important national and commercial projects of the present day—while it also appears from this pamphlet, that, through our supineness, the French are now gaining an ascendency in Egypt, which cannot be otherwise than highly detrimental to our own interest as a mercantile and manufacturing country.

The policy of maintaining a powerful ally, intermediate between Russia and our eastern possessions, has always been acted upon, and Turkey has, for a long period, been selected and upheld by the British Government with this view. Notwithstanding this powerful support, Turkey has for years been declining—has, in fact, dwindled down into little better than a Russian province; while, on the other hand, Egypt, under every disadvantage, has been rising as a nation, and making rapid strides both in power and civilization.

Reasoning on these facts, the accuracy of which we leave others to examine, Mr. Waghorn urges the policy of acknowledging the independence of Egypt, and no longer suffering her to be trampled upon by a power which she has virtually conquered. Without entering further into his arguments, we may observe that he appears to have made out a strong case in favour of Egypt, and we would recommend his pamphlet to the perusal of our commercial readers, as containing the results of long residence and observation in a country which is here but little known, but with which we may hereafter become more closely and beneficially connected.

The London and Edinburgh Philosophical Magazine and Journal of Science. Conducted by Sir DAVID BREWSTER, K.H., LL.D., &c.; RICHARD TAYLOR, F.L.S., &c.; and RICHARD PHILLIPS, F.R.S., &c. Vol. X.; January to June, 1837. Longman and Co., London.

The present volume of the "Philosophical Magazine" is well calculated to maintain the high character of the work, guaranteed as it is by the known abilities of its conductors, and of the numerous scientific individuals who contribute to its pages. Among those papers which are of general interest, we would name one by Mr. Alfred Essex, on the "Art of Painting in Enamel," in which that singular and beautiful process is ably described, while as bearing on our own more immediate province of mineralogy and geology, we may point out several valuable contributions.

Of this class are the following—"notice of a *vein* of bituminous coal in the vicinity of Havana, in the isle of Cuba," by R. C. Taylor, Esq.; a notice of the "geology and of the mineral region of part of Cuba," by the same author and Mr. Clemson; a paper on "the carboniferous series of the States of New York and Pennsylvania," by Thomas Weaver, Esq.; and an article on the "composition and origin of porcelain earth," by Dr. Boase.

From each of these papers extracts could easily be made, we shall confine ourselves, however, to the notices of the geology of Cuba, as these present facts which are both singular and little known. The vein of bituminous coal appears, from the description and figure by which it is accompanied, to be very similar to the "*pipe veins*" of this country. The occurrence of a carbonaceous deposit in this manner is, however, a very remarkable and unprecedented fact; the appearances it presents are thus described:—

"The vein commences or crops out immediately under the thin alluvial soil of the surface, and follows an irregular, but nearly perpendicular direction downwards, so far as it has been traced.

"It is visible to the depth of full thirty feet; but the bottom of the excavation being covered with mud, which had been washed in during the rainy season, we could not readily define the breadth of the vein there; but it was stated by the overseer to be nine feet thick. From even this small opening many tons of pure coal had been extracted, and were deposited in a large building adjacent.

"On the north side of the excavation the vein is solid; having a thickness gradually increasing to four feet at the depth of twenty feet. The coal lies in parallel horizontal layers, of from one to four inches in thickness, across the vein. Sometimes these layers appear to have their horizontal position partially disturbed, particularly near the outer edges, in which case they were slightly curved. Where an accidental derangement of the vein has taken place, this curving up of the outer edges or extremities of the planes of stratified bituminous matter is particularly observable. Near the walls of the vein, the laminæ of the coal for a few inches in depth are deflected, as if they had been pressed by the sides or walls. Here the structure becomes bacillary, and the coal on the slightest effort divides into irregular polyhedrons. The surface of this coal, when detached from the walls, instead of being smooth or covered with any kind of bituminous shale, is rough, and presents a bacillo-fibrous appearance, similar to the structure observed in arragonites and other fibrous minerals. Two or three small branches or *filons* are seen passing from the main vein at about the depth of twenty feet, occupying small fissures in the surrounding rock. These branches all rise towards the surface, but at different angles.

"On the south side of the opening of the coal, in rising towards the outcrop, parts off into two separate veins, longitudinally, for an uncertain space; and is apparently more disseminated through this rock than on the north side.

"With regard, therefore, to the mine of Casualidad, we have here, in the strictest sense of the term, *a coal vein*, unlike any we have before witnessed in any part of the world. It is distinguished from the ordinary deposits of coal, in as much as those occur in distinctly stratified beds, and almost invariably exhibit abundant traces of organic remains, for the most part of vegetable origin; whereas we have before us a geological phenomenon of no common occurrence, yet whose origin seems sufficiently intelligible. It was evidently, originally, an irregular open fissure, terminating upwards in a wedge-like form, having various branches, all of which have been subsequently filled with carbonaceous matter, as if injected from below, and that not by slow degrees, or by an infinite succession of depositions, but suddenly and at once.

"This coal is wholly unaccompanied by traces of vegetable remains, or by those beds of bituminous or other shales which almost invariably envelop, cover, or accompany ordinary coal seams, whether in secondary or transition formations. The layers or transverse seams of which we have spoken appear to maintain a horizontal position, that is to say, at right angles to the vein, and when otherwise, the result is accidental, or produced by any after cause. This fact, together with the bacillo-fibrous structure observed, where the coal is in contact with the walls, are among the reasons which lead us to lean towards the supposition that the fissure was charged or filled at once, and that these characteristics are the result of the carbonaceous matter having passed to a more solid state in its present position.

"It would be rash to pronounce an opinion on the presumed extent of this deposit, or to speculate on the probable magnitude of the vein, below the point at which it is visible at the depth to which we have had access. But if the vein continue to enlarge downwards, in the same proportion as it has augmented in the first thirty feet, or even if it holds the present breadth of nine feet, the quantity of this mineral must be very great, and will prove a highly acceptable discovery, so near the precints of a great and flourishing city, so convenient to the Embarcadero on the sea-coast, and in the midst of a district from which nearly all the timber for fuel has been long since removed."

Information relative to the mineral riches of Cuba cannot be otherwise than highly interesting in this country, we therefore extract that portion of Mr. Taylor's paper on the geology of this island which treats on this subject:—

"*Copper Ores.*—The surface ore, or the mineral substance containing copper, that is found at the outcrops, or upon the back of the veins within a few feet of the surface of the ground, differs materially in its physical characters and in its chemical composition from that ore which is found to predominate in the same lode at greater depths. The term surface ore is here applied to amorphous or informal masses of mineral, of different colours, containing more or less metallic matter.

"Frequently at the outcrop of veins containing cupriferous ores, the term surface ore is applied to a heterogeneous mixture of several distinct mineral species, of which copper forms one of the constituents, associated with other minerals of little or no value. These ores are generally red, brown, black, green, and the different hues that grow out of an indiscriminate mixture of those colours; the most prominent of these species being the oxides, sulphurets, silicates, and carbonates of copper, with iron, &c. As we descend upon the vein the ore assumes a different character. The copper is then found in combination with sulphur and more or less iron; the mineral having a foliated structure, which it owes to an intimate mixture with the foliated magnesian rock, its gangue. At the depth of ninety feet, as we observed in the Buena Isabela mine, that structure is lost, and a more compact and permanent form is assumed. Occasionally the foliated character is maintained, but it is not so marked as nearer the surface. This ore is raised from the depth quoted in masses of from fifty to three hundred pounds weight each, and free from gangue; but masses have been detached, by blasting, of the estimated weight of one thousand pounds.

"Native copper is met with, particularly at the mine of *San Fernando*, on the upper portion of the lodes, and descending to the depth of thirty yards. This occurs in masses of from ten to two hundred or more pounds weight.

"*Chromate of Iron* of great purity occurs in beds and irregular veins in the serpentine rocks at several places in this district. At one point masses containing many cubical yards project several feet above the general surface of the Savana.

"*Discovery and Progress of the Mines in the Savana Region.*—It does not appear that any knowledge of the actual existence of lodes of copper on the north-east side of the island of Cuba prevailed before the year 1830. Soon after this time, however, a couple of Mexican working miners were employed to explore for gold amongst the hills and open Savanas within the district of Holguin. It was during their ineffectual researches for the more precious metal in this quarter that the first copper veins were discovered; and subsequently the denouncement of *San Fernando*, containing three veins, was commenced, and entrusted to the management of a Mexican manager, by John Bedopia, Esq., an English resident on the island. We have taken the liberty of mentioning this gentleman personally, because to his individual enterprise we are in a great measure indebted for determining the existence of mineral veins within this district.

"The mine of *San Fernando* has continued to be worked by negro labour, although but slowly, and under all the disadvantages of the old Mexican system and incompetent management. The ore is a sulphuret, of a bronze green colour, rich in copper, and intermixed with rich grey ore, and, to the depth of the first thirty yards, with native copper.

"In the same vicinity have been subsequently made by the same proprietors the denouncements of *Socorro, San Antonio, San Juan, Mina Inocentes,* and *San Olivo.*

"In the meanwhile, during the active search for gold by numerous individuals, discovery was made of the vein denounced under the appellation of *San Augustin*, and which now comprises the four veins of *Prosperidad, Santa Isabel, San Augustin,* and *San Nicolas.* The ore of *San Augustin* is as rich as any in the district, so far as has been examined, varying from 23·30 to 51·60 per cent.

"The denouncements of *La Buena Isabela* and *Perseverancia,* commenced being mined in 1834. A few English miners were employed in the former in the year 1835, and after proving the vein, the works were suspended on account of some temporary difficulties on the part of the owners.

"Stimulated by the success which attended the mining of the *Cobre* veins in the vicinity of *St. Iago de Cuba,* the researches on the north side of the island were continued on a limited scale by a few individuals. During the last two or three years, notwithstanding no mining undertaking had been conducted so far as to bring in a single dollar, great activity was exhibited in searching all the Savanas through a great range of country. These explorations, however eagerly prosecuted, have up to the present moment led to no other new denouncement than that of *Savana Veija.* Indications and traces have been observed at detached positions, but among these no works, except of the most trivial and superficial nature, have been proceeded with.

"All the denouncements made up to the time we are now writing are comprised within an area of only five miles in length by two in breadth. That of *Savana Veija* is among the most promising. The principal vein was discovered in 1835, but copper had been traced at one or two points on this Savana three or four years earlier. There appear to be seven or eight good veins here, which are imperfectly proved. No capital has hitherto been employed in this undertaking; and in fact this may be said of the entire region, with the exception of the *San Fernando* and the Good Isabella mines, and even in them it has been expended to a limited extent only.

"Assays of the ores from the various denouncements within this region have been made in abundance, with a view to the ascertainment of their quality. These results, however satisfactory, it is scarcely necessary to communicate in detail here."

With these extracts we take our leave of the "Philosophical Magazine," expressing our high sense of the ability with which it is uniformly conducted, and the great scientific value of its contents, from which the above interesting notices have been taken.

The American Journal of Science and Arts. Conducted by BENJAMIN SILLIMAN, M.D., LL.D., &c. &c. &c. Vol. XXXI. (for the last six months of 1836). Maltby, Herrick, and Noyes, New Haven. 1837.

[Second notice.]

On taking up this volume a second time, we again follow the rambles of the "Naturalist" over the new and varied district, which he describes, and passing over much interesting matter, come to the following account of the deposits of iron and of coal in the vicinity of "Zoar" and "Newcastle:"—

"*Ferruginous Deposits.*—The great ferruginous deposit, which crosses the state like a belt, in a south-west and north-east direction, is here found in its greatest purity and abundance. It first makes its appearance about five miles north of this place, and is known to extend south for at least thirty miles. It does not hold of this width for the whole distance across the state, but can be traced without difficulty from near the mouth of the Scioto to Conneaut, on the Pennsylvania line. It lies here about forty or fifty feet above the white sand rock, and near the tops of many of the hills. The ore is found in three separate beds, of about six or eight inches in thickness, and about two feet apart, lying in a matrix or bed of yellow ferruginous clay. The bottom stratum of ore rests on a deposit of blueish brown clay, which, when dry, assumes a foliated structure, and is very similar to that found in the bottoms of ponds. These deposits were once continous, but are now found in broken tabular masses, of from ten to one hundred pounds weight. Its structure is lamellar, splitting into thin folia, or concentric layers, when exposed to the air and sun. The ore is very abundant, and yields from 800 to 900 tons from an acre of surface. In the furnace it affords about forty per cent. of iron, or two and a half tons of ore yield one ton of pig metal. It crops out on the abrupt and sloping sides of the hills, near their tops, and is yet pursued only so far as it can be done by excavating the superincumbent earth. I visited the mines on the Zoar lands, where it is found in great purity and abundance. Directly over the iron ore is a deposit of coal, of two or three feet, separated from it, however, by a bed of shale. Below the ferruginous deposit is another bed of coal; and near the base of the hills, fifty feet below the white sand rock, is a deposit of limestone, several feet in thickness. I could not discover any fossil shells or impressions of plants in the iron ore; but one bed of it, however, is columnar in its structure, when burnt or roasted, much resembling one species of fossil madrepore, common to the valley of the Ohio. The deposit is very abundant in all the hills, and large heaps of it are seen along the sides of the canal, for the use of the furnaces north of the iron region, along the Tuscarawas. As we descend the river south, coal becomes more abundant, and the ore dips down to the base of the hills, and finally disappears under the superincumbent strata. Salt-water has not yet been found here, although searched for to the depth of three hundred feet. It is very abundant thirty or forty miles east of Zoar, on the waters of Yellow Creek.

* * * * *

"*Newcastle Coal.*—Sixteen miles below Zoar, at Newcastle, coal is found at a less elevation, and much more abundant. The deposit here is six feet in thickness, and extensively worked. Wooden slides, on the sides of the hills, conduct the coal from the mouths of the mines to reservoirs on the banks of the canal; from thence it is carried in boats to the summit, and to the valley of the Scioto. It is said to be of an excellent quality. At the present day, with all the lights that have been thrown upon the subject by chemistry and the study of fossil plants of the coal series, no well-instructed and sound geologist would hazard the long exploded theory of the 'mineral origin of coal' by 'ejection' from the interior of the earth. Although some bituminous shales are destitute of the impressions of plants, more than nine-tenths of them abound with these authentic proofs of the vegetable origin of coal; and I have never seen a piece of slaty bituminous coal, from any part of the valley of the Mississippi, that was not filled with thin layers of vegetable fibres, resembling charcoal, and lying between all the horizontal folia of the specimen. Whence all these impressions of leaves and charcoal, but from a vegetable source? Bitumen is rarely if ever found, but petroleum is abundant in the west. Its origin is plainly from vegetable decomposition—the same source as that of the carburetted hydrogen, namely, from the coal-beds under the valley of the Ohio. The vegetables forming these were deposited when the lime was in a plastic state, and filled with living shells; in the same manner petroleum is now daily discharging into the soft mud and gravel, in the beds of the Little Muskingum and Hews's river. It will be found by future geologists, when those sands shall become consolidated into rock, lodged in cells formed by the contained gases. That bituminous coal is not a mineral matter, is evident from the fact that it is not found in primitive rocks; probably because, that at the period of the formation of the deeper primary rocks, no vegetable productions were in existence; for the relics of none are found until near the period of the transition or secondary rocks, unless we ascribe the plumbago to a vegetable origin, in which case the first plants will have been coeval with the earliest slaty rocks."

Near "Newark" the author found the imperfect remains of trilobites, one of which he has figured. We proceed to extract the following ingenious theory, accounting for the state of the fossils mineralized by iron pyrites, which occur so abundantly in many of our secondary and tertiary strata:—

"*Sulphuret of Iron.*—Previously to a late number of the 'American Journal of Science,' I could never satisfactorily account for the immense quantities of sulphuret of iron, found in all our argillaceous, and many of the calcareous deposits. The beds of many streams are filled with sulphurets of all forms and sizes, from minute grains to masses of several pounds weight. Not a well is dug in the uplands, but more or less of this mineral is brought up; and from its rich metallic lustre, it always leads the ignorant to believe that they have found a treasure. Animal remains of shells and bones are often changed to this semi-metallic state, specimens of both of which are in my collection. 'Since gelatinous matter seems to have favoured the conglomeration of silica, and, consequently, the formation of silicious petrifactions; so likewise, the putrefaction of animal matter having produced sulphuretted hydrogen, if any particles of oxide of iron should happen to be present in the surrounding mud, pyrites would be formed and would accumulate about the places where the gas is discharged.' How simply and beautifully this theory explains this formation of pyrites. This whole valley is one vast cemetery of animal and vegetable remains, and while the deposits were in a recent and plastic state, and the animal bodies inhumed, gradually decayed, the discharges of sulphuretted hydrogen must have been immense; and very satisfactorily account for the vast abundance of iron pyrites found in many of our rock strata. From the decomposing pyrites, and the magnesian limestone rocks containing shells, these springs, doubtless, derive a large share of their mineral contents."

The deposit of iron ore before seen at Zoar, was again traced in another locality:—

"*Iron Ores.*—The belt of hydrated iron ore, noticed at Zoar, as crossing the state diagonally, on the outer border of the coal measures, here maintains its relation to the other deposits, and lies near the top of the hills, imbedded in clay, in similarly large tabular masses. A few miles south of this place, we strike the silicious deposit lying parallel with the ferruginous zone, and stretching north-east and south-west, nearly across the state from Pike county to Stark. At its northern extremity, it widens out to nearly twenty miles, and stretches off into Holmes county. It does not uniformly lie on the tops of the hills, but crops out on their sides, with a thick diluvial deposit over it. The general course of the deposit may be seen in the geological map of the coal measures, in the 29th vol. of this Journal, but widening more at the north than there represented."

We shall conclude our extracts from the highly interesting paper under consideration, by the following notice of the arborescent ferns, occurring near Zanesville:—

"*Fossil Arborescent Ferns.*—In the afternoon I visited a deposit of coarse sandstone, three miles west of Zanesville, which is literally filled with the broken trunks and branches of various species of the arborescent fern and other fossil plants of the antediluvian period. I brought away several specimens, and amongst them is one species which still retains portions of the spines or setæ, that grew in the centre of the scales which covered the surface and formed the cortical portion of these singular trees, so admirably fitted to the purpose for which they were apparently created, viz., that of furnishing an inexhaustible supply of fuel for man, when the present forests are removed to make room for the immense tillage that will, in time, be needed for the support of the teeming millions destined to people the earth, when wars shall cease and diseases shall be greatly diminished, if not entirely banished. Buried deep under superincumbent strata, these ancient forests lie bituminized and changed to an imperishable material, in the form of 'stone coal!' How glorious and how wonderful the providence of the Creator, in the material as well as in the moral world. The whole region about Zanesville is full of interesting relics of by-gone ages; descriptions of many of which are given in a late number of this Journal."

The Railway Magazine and Annals of Science. Edited by JOHN HERAPATH, Esq. No. XVII. July, 1837. Wyld, Charing-cross.

The present Number of the "Railway Magazine" contains several good papers on subjects relative to these undertakings. The tables for calculating heights with the barometer, are likely to be of much service in obtaining approximate levels to facilitate the first laying out of lines of Railway, without the ordinary and laborious process of actual levelling. We agree with the Editor as to the "utter uselessness of the barometer for *accurate* Railway levelling," but for the purpose we have pointed out, and within certain limits, it may doubtless be used with advantage.

The subject of the "Railway Gage" is discussed in another paper, and the preference given (we think very properly) to one wider than that generally adopted. It is most desirable that both mystification and prejudice should be removed on a subject of so much importance, and we hope the paper alluded to will be instrumental in promoting discussion so as to lead to the adoption of a uniform standard, determined upon correct principles. There is a paper deserving of attention, on "Parliamentary Committees and Inquisition on Railway Bills," one on "Railways considered as Investments," which together with the usual Railway intelligence and Reports, constitute a very good Number.

DIAMONDS.—"How many," says an ingenious practical mineralogist (Mr. Mawe), "pick up pebbles of crystal, believing them to be diamonds; and how difficult is it to convince them they are not so, even after they have been cut and polished! As it is well known, that diamonds cut glass, many imagine that a crystal, hard enough to scratch glass, must be a diamond, or something extremely near to it. The difference, however, between scratching glass and cutting it, is immense. The diamond cuts it so, that it breaks in the line, frequently under the very act; other substances merely effect scratches." When a person is not satisfied with this test, let him procure a fine file, and rub the substance forcibly; if it be a crystal, the file will wear it down; but if a diamond, it will not produce the smallest effect upon it. *Another Test.*—When crystal is cut and polished, the rays of light will pass through it, whereas in the diamond the rays are, by its great power of refraction, reflected, as it were, to the surface, whence it is that diamonds are so distinguished above all other stones for their sparkling brilliancy.

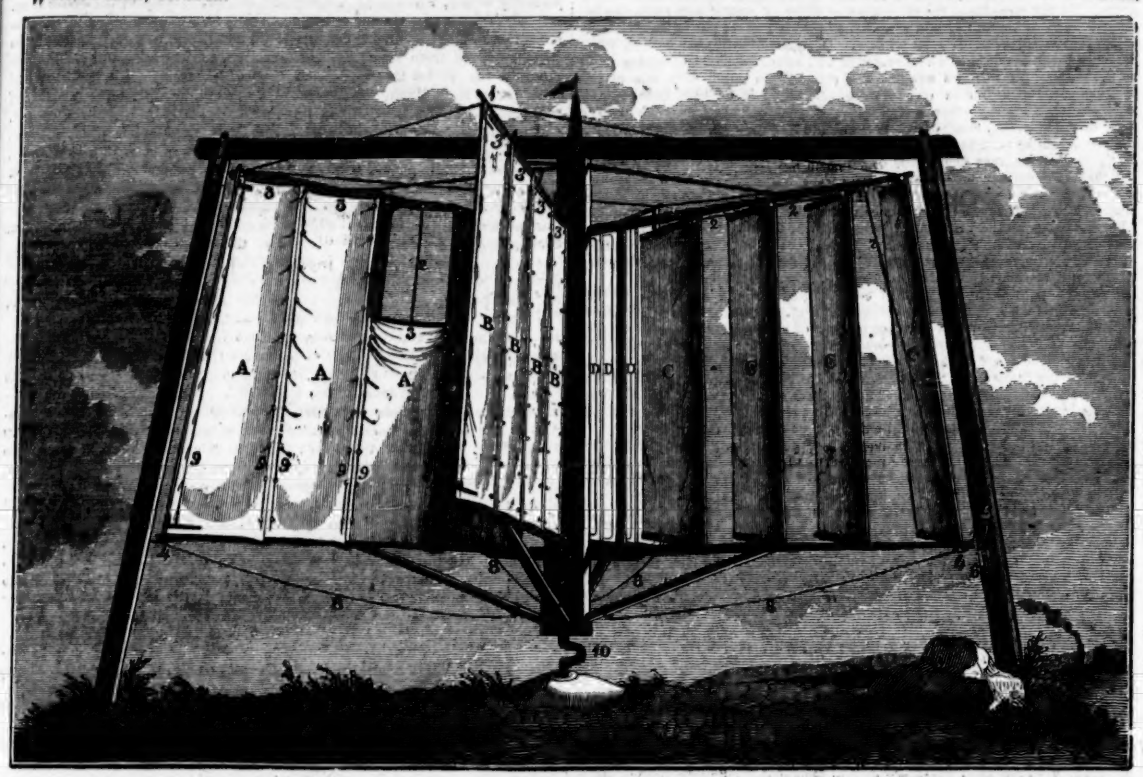
"WIND-MACHINE" APPLICABLE TO MINING PURPOSES.

The accompanying engraving is copied from a drawing sent to us by Mr. EDWARD CONCANEN, and represents the "Wind Machine," described in a former communication by that gentleman, as having been successfully applied to mining purposes. The construction will easily be understood by reference to the explanation given below; and we also insert a letter since received, referring to the subject. A power more economical than any now in use, is evidently a great desideratum in making trial of small and shallow mines, and as likely to affect this object, we are desirous of giving every publicity to this contrivance.

TO THE EDITOR OF THE MINING JOURNAL.

SIR,—I have omitted to remark, in my references to the drawing of my "Wind Machine," a circumstance especially worthy of notice—viz.: it requires no adjustment to meet a change of wind, however sudden, as a proper attention to the principles of its movements will show. Had I been aware that you would so kindly have taken notice of my endeavours as to send my drawing to your engraver's, I would have attached the machine either to a whim-cage, or to the tackle of a shaft, instead of its present simple accompaniment, a crank; there are, however, clever heads enough in Cornwall, requiring only to be furnished with the knowledge of the POWER. The application will not be an obstacle to mine agents—a class of men capable, and in the habit of, overcoming more difficulties in mechanics than any I am acquainted with; these will, no doubt, at once perceive that, as applied to whim-drawing, a difficulty presents itself, viz.: the motion has but one course: this is provided against; and so long as, by simple means, its power is to be controlled, that power will be found cheap and efficient. I shall be willing to meet any observations or objections put forth by your correspondents, because, as I have before stated, having proved its power, I trust I shall be able to do so to their satisfaction. If the principle is good, a fair scrutiny of its merits will tend to the best of all ends, and the point on which the real interest of every shareholder in England depends, "Economy in Mining." Be it how it may, I shall be able to prove, that in a fair situation, a machine upon this principle during the approaching months would clear a shaft of water to a good trying depth on the one hand, and draw all the attle from the level on the other; this accomplished, I need not state to you how much more mining work can be done for the money that would otherwise be spent on horses and coals.

Whiddon Mine, Cornwall. I am, Sir, your obedient servant, EDWARD CONCANEN.



REFERENCE.

AAAA—Four sails, upon which the wind is acting with full force.

BBBB—Four sails, upon the point of receiving the wind.

CCCC—Four sails, upon which the wind is acting on the back part; here there is nothing to prevent their opening, consequently the wind escapes, and in turn, as they take the situation of the quarter now facing the reader, they will close on the resisting side, and become the acting power, as AAAA.

DDD—The sails of the opposite quarter coming round, they are opening by the same rate at which BBBB are closing.

11111111—An eye in the upper corner of each frame.

22222—The line which, after passing through the hanks which are hung to the spars, enter the eye at 1, and so through on the other side, seen at AAAA, through another hank, and fastened to an iron at 3, which is sufficiently heavy to drop the sail when let go at 4.

33333—Iron slips fastened to the canvass.

4444—The plugs to which the lines are hitched while the sails are up.

5—An iron bar, which dropping upon the cleet at 6, as the quarter comes round against the wind; this resists the small bar 7, which, turning suddenly, throws off the line at 4, when the sails instantly drop, as is partially shown at A.

8888—The line by which the four upper lines are recovered when it is necessary to hoist up the sails.

9999—The rods that bear the rings upon which the sails run up and down.

10—The crank to which machinery is connected.

N.B.—For plain water-drawing practical sails will not be required, but for whim-drawing, and drawing from a working shaft, it will be necessary to stop by lowering when required. For all purposes requiring proper check and regulated power, the primitive contrivance of the crank is discarded, and the rotary motion applied to cog-wheels and cylinders, upon principles already arranged.

Note.—The power of a machine upon this principle, measuring twenty four feet from the centre of the axle to the end of the arm, placed in a proper situation, is capable of drawing a six-inch box thirty fathoms.

EXTRACTS FROM FOREIGN SCIENTIFIC WORKS.

No. XIII.

ON SPRINGS AND ARTESIAN WELLS.

The quantity of water which annually descends upon the earth's surface, is equal to about a yard in depth; the greatest part is returned, by evaporation, to the atmosphere; but the remaining portion sinks into the soil, and again appears in the form of springs on the surface. Our present purpose is not to explain and prove their origin as derived from rain, this subject having been exhausted by the treatises of Perrault, Mariothe, Halley, and others; we here intend merely to glance at some circumstances attending their formation—the causes why they are more abundant in some countries than in others, in mountains more than in plains.

The rain, in falling on transition formations, filters between the particles of sand and earth of which they are composed, and makes itself a passage by its gravity, descending till it meets an impervious bed, which is generally clay, more or less pure. Not being able to descend lower, it glides, as it were, over it, following the direction of the strata, and appearing at length on the surface, at the intersection of the latter, by the bed above-mentioned. Sometimes beds containing water have a concave form, and thus become capacious receptacles for the filtered waters, which there remain like subterranean marshes or reservoirs, in which is immersed a part of the pervious stratum above them. The level of these stagnant waters being raised by the accession of constant filtrations, at length finds an outlet on the surface of the earth, sometimes at a considerable distance, and thus produces a spring; and these subterranean reservoirs or lakes, often form the bottom of wells. Springs, therefore, are only an indirect result of the filtration of rain water; such, for instance, as those of Loiret, near Orleans, which rise above the surface, on a level entirely flat, and are derived from the filtration of the waters of the Loire, flowing at the distance of a league. The principal of these springs supplies thirty-three cubic yards of water per minute, at the lowest rate.

If the rain fall on a rock, either immediately or after passing through a transition stratum, it penetrates the fissures and clefts until the rock becomes quite compact. The various streams then uniting at their lowest level, pursue those channels which lead to the surface; whence, it follows, that in rocks possessing few fissures, or where those fissures are not deep, springs are very numerous, but less abundant in their supply: such is the case in primary formations, especially granite, in which the waters burst forth on all sides, and are pure and limpid. But if the rocks be pervious to water, and if their fissures be of great depth, as is the case, particularly in secondary limestone, then the rain-water often descends even below the level of the neighbouring valleys, and forms those subterranean reservoirs of which we have already made mention. The vast caverns in these rocks provide them a convenient receptacle; and the lowest of these cavities is, as it were, the aqueduct to the superfluous streams, and gives rise to a spring, the ascending power of which will be, in some degree, proportionable to the superficial extent of the reservoir, or rather to that of the space contributing to the supply. In conformity to this rule, springs must be fewer in number in such formations; entire valleys, within the compass of several square leagues, will be found without them; but when they do appear, they will be of remarkable magnitude. It is from limestone mountains those are derived which are celebrated for their volume; such are, among others, the spring of Vaucluse, whose stream is navigable, in a boat, into the cavern whence it issues; the Loire, in the Jura mountain, which supplies water-power to four forges, and the Touvre, near Angouleme, which, at the distance of half a league from its rise, turns twelve or fifteen water-wheels at the Canon Foundry of Rouelle. In the caverns of this district one may trace for leagues the subterranean channels, whose union produces this prodigious spring. At the foot of the limestone precipice on the borders of the Department of the Lot, opposite Cahors, I have seen another spring emitting two cubic yards of water every second, and turning four mills on the spot.

The various position of caverns and their communications in the same mountains, give rise to the phenomena of intermittent springs, described in works of natural history, as in Brisson's Dictionary of Natural History, article—Fountains. If the channel by which the water escapes from the subterranean reservoir be bent, in the form of a syphon, and if it be able to emit more water than what enters the basin, after having exhausted as much as there may be between the level of its convexity and its point of union with the reservoir, the flow of water will cease, and will not recommence until the former, having received fresh filtrations, shall again rise to the level of the convexity of the syphon. This is the case with the spring of Fontesorbe, near Bellesta, in the Department of Ariege. In dry seasons its intervals are decidedly marked, when the water flows about half an hour so abundantly as to turn a mill, and then ceases for another half hour. At the time when I observed it, it required about ten minutes to reach the level—it then ran freely for thirty minutes, and was thirty-five minutes in lowering the level. Scarcely had it reached its greatest depression, when it began to rise again, and about ten times more water was emitted at its greatest flow than when at the lowest ebb. Apparently the distance between the point where the water flowed from the syphon, and that where it reached the surface or fountain head, as well as the circumstance of the water being derived from separate reservoirs, were the cause of the difference between its manner of intermitting and that which occurs when water is poured through a common syphon.

The nature and disposition of mineral beds may also give rise to a kind of springs, which we cannot here pass unnoticed. This phenomenon appears in formations pervious to water, covered by or alternating with impervious ones. The water penetrating into the former, is there retained as in a reservoir, to which the latter serve as walls. Now, if one of these be pierced at a point below the level of the water in the reservoir, the fluid will thus find an outlet and rise, if a suitable passage or conduit be provided, to an equal level, just as the water passing through an orifice formed in the side of a vessel, rises, or will have a tendency to rise, to the same level as that of the remaining fluid in the vessel itself. The province of Artois exhibits numerous instances of such springs. The soil at the eastern part is a limestone, very much fissured, and, in consequence, well adapted to admit of the filtration of the waters falling or flowing above it. On proceeding eastward, the limestone gradually extends under the transition formations, constituting the spacious plains of Flanders, whose inferior stratum is a thick and very extensive bed of compact, tenacious, homogeneous clay, impermeable to water. Towards the junction of these two formations, at the parts where the transition mass is not so thick as to prevent the reaching of this bed, on boring through the clay, the water which it held confined beneath its level in the mass of limestone, springs up with velocity, and rising in the boring-pipe to twenty, thirty, fifty, and even one hundred yards above its lower extremity, according to the locality, appears above the surface of the ground. Such perforations of the soil, furnished with a suitable apparatus, are denominated Artesian Wells, from the name of the above province, where they are generally adopted. M. Garnier, who made them his particular study, has just completed a work, in which he points out the geognostic character of the districts where they are to be found, and gives all the details relating to their establishment. His treatise is entitled "De l'Art du Fontenier sondeur et des puits Artesiens, par M. Garnier, Ingeneur, au Corps Royal des Mines," and was received with applause by the "Society for the Encouragement of Industry," at a sitting held the 3d of October, 1821. The Government, considering it a matter of public interest, ordered the work to be published.

Springs in general, under equal conditions, are more abundant in mountains than in plains; the chief reasons for which may be, first, because there is more rain in mountainous regions. Mountains exercise an influence over the clouds, since, when the atmosphere becomes obscured with clouds, they are observed to gather first round their summits; and they most frequently accumulate in their vicinity. And here we may inquire, what is the nature of the action of mountains on the clouds? It is not an effect produced by their attractive force, as is commonly asserted, for if this force propelled a distant cloud against a mountain, the moment it came into contact it would act with augmented energy upon the particles of the cloud, which are entirely distinct from each other, and would dash them against the sides of the mountain, and thus cause the cloud to disappear. The sea throws on its shores the objects floating upon it, and so it is probably in the aerial ocean with respect to the vapours with which it abounds. However, to return, the fact is established by experience that the greatest quantity of rain falls in elevated localities. By observations recently made, during ten years, the rain which falls annually in Geneva, at the foot of the Alps, amounts to twenty-four inches eight lines on an average; and at less than twenty leagues distance, at the convent of the Great St. Bernard, near the summit of these mountains, the average is fifty-nine inches three lines, which is more than double the quantity.—See the "Bibliotheque Universelle," vol. xxxvii. p. 219.

Secondly, there is probably a greater invisible preceptation of vapours at the tops of mountains; in other words, the dews are more copious, at least under certain conditions. Bergmann asserts, according to Mercator, that it never rains in the island of St. Thomas, but that in the centre there is a considerable mountain, covered with woods, which is perpetually surrounded with clouds, and whence rivulets flow, fertilizing all the country.—See his "Physical Description of the Globe," (Physicalische Beschuibungder Erdkugel). Some downs have been observed to produce springs, which dry up in the hot season, and begin to flow again on the return of wet weather; now, if these downs, says Bergmann, attract the humidity of the air, and resolve it into water, what may not high mountains do in this respect? *

The trees, plants, and mosses on mountains cannot fail to contribute to the formation of springs on them. Besides their action in condensing the vapours suspended in the air, the coolness they spread around, and their obstruction to the rays of the sun reaching the earth, prevent, or at least diminish, in a considerable degree, the evaporation of the rain, and in a manner compel it to form springs, by entering into the earth. To the clearing away of forests during the troubles of the Revolution, is ascribed the diminution of streams in some of our provinces.

Thirdly, the ice and snows on the summits of high mountains are constant feeders of numberless springs at their foot, even in the greatest droughts; and it is precisely at periods of the greatest heat, when our springs are dried up, that these augment their supply, and thus contribute to maintain the existence and force of the large streams which traverse the surface of the globe.

The form of mountains, their elevation above their surrounding plains, their generally inferior permeability to water than the strata of those plains, contribute to the speedy re-appearance of the rain-water on the surface of the soil, and, consequently, to cause springs to be more frequent there than in the lower countries.—*Traité de Geognosie*, vol. i.

FLINT IN VEGETABLES.—It is curious, and hitherto inexplicable, that flint, which is one of the most intractable of all substances with which the chemist has to deal, makes it way by some means or another into the substance of the tenderest plants, and it becomes visible and tangible upon the surface of some plants. Two pieces of common cane, when stuck together, will produce flashes of fire like two flints. The reason is that there is abundance of flint upon the surface of cane. Many beautiful specimens are brought from abroad of fossil wood, where the whole substance of the wood has been replaced by flint, leaving the form just what it was, so that the granulation, the knots, the fibres. are all the same in appearance as they were in the tree, but the whole is no longer wood but flint, capable of the highest polish. No one can conceive how this happens, we only know that it is so.

* This suggestion of Bergmann seems to militate against our author's opinion above expressed, against the principle of attraction in mountains.—*Translator.*

THE MILL-STONE QUARRIES OF NIEDER MENDING.

In a very picturesque part of Germany, through which flows the noble river so emphatically called "Old Father Rhine," by the Germans; and at about five leagues lower down than Coblentz, on the left-hand side of the river, are situated the very extensive mill-stone quarries of Nieder Mending. They were discovered and opened by the Romans, who long extracted from them stones for the hand-mills, which formed an indispensable part of the equipment of a Roman army. Since then they have been constantly worked more or less; for even the wild hordes of our Saxon ancestors, who also spread over this part of Germany, destroying the dominions of the Romans, and avenging their slaughtered and conquered countrymen, were acquainted with the means of grinding corn and bruising malt, and contrived to extract mill-stones from the Roman quarries. At present they are worked to a great extent, and not only supply all the neighbourhood, but are sent down the Rhine into Holland, in great numbers, whence they are again further exported to England, and to the West and East Indies. The sending them down the river forms one great branch of the commerce which is carried on by all the little towns and villages situated on the Rhine in this vicinity, though the little town of Andernach is its principal seat. The mode of conveyance is not expensive, the stones being merely laid on some of the immense rafts of timber which are annually floated down the Rhine, from the upper part of Germany, to supply the industrious Dutchmen with boats, ships, and houses. Numerous small rafts which come down the little rivers, that are lost in the course of the Rhine, are united at Andernach into one great floating forest, and thence, carrying along with it many travellers, as well as a great number of people necessary to manage it, and various heavy substances, the produce of Germany, this forest descends into Holland, to be again broken up and distributed, and, when converted into ships, destined to bear the product of one quarter of the globe to the other.

The principal quarries are situated in a plain called Hacher, about half a mile from the village of Nieder Mending. They are seven in number, about fifty feet deep each, and employ a great many hands: while some are raising the ponderous stones to the surface, by means of cranes and wheels, others are cutting them; a third class are piling them up, and a fourth are loading the vehicles which are to carry them away. An opening is made into all these quarries in the same manner, which is curious, not only in itself, but from the long time it has been practised. The strata from which the mill-stones are cut, lies fifty feet below the surface, and it is difficult to imagine how it was first discovered. To arrive at it a shaft is sunk of the shape of an inverted cone, or of a funnel, being twenty-five feet in diameter at the top, eleven or twelve feet diameter at the bottom, and fifty feet deep. Around the sides a very narrow spiral path is made, by which the workmen descend, and even children run down and up for their amusement. It is customary for five or six families to unite their labours to sink such a shaft, and with time and much hard work, they are thus enabled to reach stones, which are the means of supplying them with both meat and clothing. The earth through which they have to dig, is formed partly of gravel and partly of large masses of a compact lava, which, however, it requires no very extraordinary force to break through. Arrived at the depth of fifty feet, a hard, blackish, heavy stone is met with, full of small but regular pores, which gives a few sparks when struck with steel, but is not at the same time so hard but that the workmen can fashion it to their will, with strong and well-tempered tools. Mineralogists describe this stone as a sort of lava, or like the melted mass which flows down burning mountains, and suppose it to have been produced by those subterranean fires which once were the means of effecting such great changes over all the surface of the globe, and which still exist in various places. They suppose that it extends at least all over the plain already mentioned; but as yet never having been dug through, its thickness has not been ascertained. Were this stone solid throughout its whole extent, it would have been nearly impossible to work it; but, on cooling, it had separated into numerous masses of a prismatic form, which enable the labourers to interpose wedges or levers, and break off pieces large enough to make mill-stones of five or six feet in diameter. So many of these have now been taken away, that immense galleries have been cleared out, which, separated from each other by the prismatic columns left standing to support the roof, like stalactites in an artificial cavern, have a resemblance to the most ancient of our gothic cathedrals. Every thing in them seems vast and grand, except the beings so insignificant in appearance at the side of these enormous pillars, by whose labours, however, they have been brought to light, and can be crumbled to dust. The workmen breaking off fragments of these gigantic columns, the children removing the rubbish, the numerous strokes of the hammers on a clear sounding stone, the sparks which, from their blows, fly through the darkness, the lamps hanging from the roof to light the upper parts, form, altogether, a singular spectacle, more astonishing and more pleasing than the gayest theatrical show. Even the danger which is now and then announced by the falling stones, adds to the interest of the scene. While visitors shudder with doubts of their own safety, they contemplate with satisfaction the hardy and industrious mechanic, who patiently goes through all this toil and braves all these dangers to lead an honest life, and rear up his infants, who may truly be said to be nourished by the sweat of their parents' brow.

ÆGINETAN MARBLES.

It may be interesting to the public to know that the sculptures from one of the Tympana of the Temple at Ægina, now to be seen at the British Museum, are those discovered about the year 1815, by Baron Haller, a German architect, Baron Stackelburg and Mr. Linck, two German painters, and Messrs. Cockerell and Foster, English architects. They were found among the ruins of a temple on the summit of the high hill of Ægina, which is easily distinguished from Athens, distant in a straight line about eighteen miles, and lying in the centre of the Gulf, which takes its name from the island. The five artists above named were pursuing their studies together at Athens, and of course, among other objects of antiquity, visited Ægina. The ten figures of the east pediment are those, the casts of which have recently been put into the British Museum. They represent a combat of warriors engaged in a deadly strife, suddenly separated by Minerva. We are not aware whether the subject of the group has been satisfactorily ascertained. But as one of the figures has the Phrygian cap or helmet, it may, perhaps, represent one of those popular traditions connected with the siege of Troy. We should imagine that all the figures, which originally formed the group, are not preserved, as the composition, instead of presenting the fulness of subject which marks the sculptures of the Tympana of the Parthenon, appears meagre and deficient. The character of the sculpture is stiff and hard, but simple; the anatomy, of a conventional style, then probably considered good, but not displaying that refinement which distinguishes the age of Pericles. The size of the figures is under that of the life, the Minerva, who stands erect in the centre, not measuring more than five feet high, independently of the plume of her helmet. The expression of the heads is unmeaning. The belts for the swords were affixed to the marble, and were most probably of metal. Many tresses of hair and parts of helmets were attached by metal nails. The drapery is of the straight long-folded Egyptian or early Etruscan style. All these peculiarities, which were distinctively termed Æginetan by the ancient Greeks themselves, render these groups highly valuable in an historical point of view. There cannot be a doubt that they are of a period prior to the sculpture of the Parthenon, but to what precise epoch they may be assigned antiquarians are not yet agreed. The temple itself, of which they formed part, is one of the most pleasing and elegant examples of Grecian taste now existing. Its elevated situation commanded a view of the coast of Attica and of the Peloponnesus. The spot is fertile, and the sea a short distance washes the foot of the mountain that it crowns. Twenty-five columns still remain of the exterior, and two or three of the interior peristyle. It was six-columned in front, and had a colonnade all round, and the cell was lighted from an opening in the roof. Many architectural peculiarities distinguish this edifice, which will doubtless be fully elucidated by Mr. Cockerell, who we believe is engaged on a work, which is specially devoted to this temple. Two small figures holding each a flower in her hand, with a large lotus or honeysuckle ornament between them, formed the groups which terminated the apex of each pediment; and the fragments of winged sphinxes were also discovered, which doubtless occupied the extremities of the inclined cornices. A great many of the tiles were found, as also the antefixæ, which were of terra cotta, covered with a thin coating of plaster, painted with a black colour, and light and dark ochre.—*Athenæum.*

ROCK SALT MINES OF CHESHIRE.

The following interesting account of the Marston rock salt mine, near Northwich, in Cheshire, is given by Sir George Head, in his "Home Tour through the Manufacturing Districts." This mine has been worked for about sixty years, and contains an inexhaustible store of the useful mineral for which it is wrought:—

"Having waited with my conductor a few minutes, till the engineer had put a little steam on, we both stepped into a round tub, and, standing upright, holding by the chains, were let down very easily. I cannot express the delight I felt at the scene around me, which surpassed anything I had anticipated—creating those sensations I remember to have felt when first I read of the pyramids and catacombs of Egypt. Here was a magnificent chamber, apparently of unlimited extent, whose flat roof presented an area so great, that one could not help being astonished at its not having long since given way. Yet there was no apparent want of security, it being sound and durable as if formed of adamant. Here and there pillars, in size like a clamp of bricks in a brick-field, tendered their support, presenting to the view an array of objects that broke the vacancy of uniform space. My idea of the extent was as if an area, equal to the site of Grosvenor-square, were under cover. In the meantime, the glistening particles of crystal salt on the walls, and the extreme regularity of the concentric curved lines, traced by the tools of the workmen, were very remarkable. Occasionally the mark of the jumper-chisel was observable where recourse had been had to blasting the solid rock. I made a few blows against the side of the mine, with one of the heavy-pointed pickaxes in ordinary use, and found it as hard as freestone. Underfoot the whole surface was a mass of rock salt, covered with a thick layer of the material, crushed and crumbled to a state that exactly resembled the powdered ice on a pond that has been cut up by skaters.

"Experiments have been made by boring to a depth of seventeen yards, but they have neither perforated the rock-salt, nor do they at present know the thickness of the stratum. The height of this excavation is about fifteen feet, within which space the salt is estimated as being of the best quality. Above it is somewhat inferior. I was informed that thirty-five thousand tons of salt were annually dug out of the different levels, and that the area of the whole together amounted to forty-eight statute acres. A considerable quantity of this salt is exported to Prussia.

"At one part there is a vista of two hundred yards in length, which has been dignified with the name of Regent-street. Here occasionally pic-nic parties are celebrated; and on a large table of coarse deal boards, were the evidences of deeds of wassail, performed at a feast of this description, which had taken place a few months before. An empty jug and sprig or two of evergreen lay forlorn and neglected, while I observed natural tokens, indisputable and abundant, of mice that had joined in the revelry. These little animals invariably establish their residence under ground, wherever men lead the way. At the coal-pits at Whitehaven, for instance, they are plentiful at a depth of 140 fathoms, being brought there originally, probably in bundles of horse provender. Were it possible, within this mine, to provide against the inconvenience of smoke, there not being any efficacious outlet for its egress, I cannot conceive a place better calculated, with proper appendages and decorations, to give effect to a fête on a magnificent scale. As it is, and as regards light and smoke, people must be content with a choice, either to have too much of the one, or too little of the other.

"Every one who descends this pit ought to bring a good Bengal light instead of the preparation vended by the learned chemist of Northwich. This is a yellow powder, a quantity of which being placed on the ground, and ignited by a piece of lighted paper, engendered for a few seconds a tantalising glare, which sank exhausted before it was possible to take an adequate survey of the objects around. For ordinary purposes, we had recourse to common tallow candles.

"Having wandered a long way through vast space, but almost in darkness, we came again to the foot of the shaft. Previous to ascending, my guide went a little out of the way, in order to carry a pail of water to an old horse, who, as the workmen were absent for the whole day, was standing by himself in perfect solitude, and, till we came, without any light at all. Alone and in darkness, he must, poor fellow, from necessity, live for many hours in the year, and pass thus neglected a very considerable portion of his time. He loudly expressed his gratitude for the water, and I took an opportunity of examining his condition while he was drinking. I was surprised to find it particularly good; unlike the flaccid, though fine-coated state of horses in coal-pits, his was that of a firm crest and perfect health; a fact I attribute especially to the salubrious effects of the salt. His stall was comfortable and dry, as was the whole space below contained in this pit. I saw no appearance whatever of water during the whole time I was below.

"The salt, after being prepared by the solution of the rock, and evaporation, is formed by wooden moulds, with holes at the bottom, to allow the remaining water to pass through, into cubical blocks, and in this state shipped, either by the river Weaver and canal to Western Point, and thence into the Mersey, or by the canal southward.

"A considerable quantity is prepared from the brine springs, some of which are so strongly saturated, as to hold in solution the greatest possible quantity of salt. To the water of some of these springs, rock-salt is added while boiling in the pans. From these springs the water, or brine, is raised by a shaft sunk, and a pump worked by an ordinary steam-engine."

Earths.—All varieties of clay, and stone, and gravel, are composed of metals chemically combined with oxygen, that is to say, with a kind of air which forms one of the elements of the atmosphere and one of the elements of water. These metals are found in an uncombined state, but the chemist is able to separate them from the oxygen with which nature has united them, and to measure accurately the proportions of metal and of oxygen which enter into the composition of earths.

Meteoric Stones.—In a lecture, Mr. Faraday has admitted the extreme difficulty of accounting for the existence of these substances and their descent upon the earth. He says it is not conceivable that they should be formed by the condensation of gases in our atmosphere, and they are of a specific gravity much beyond that which we know to belong to the general mass of the plants of our system. There is no substance in these meteoric stones which is not common to our globe, but they are combinations such as we have no examples of except in themselves.

Caverns in Belgium.—Some time ago a large cavern, full of beautiful stalactitical formations and incrustations, was discovered near Tilf. A second, far more splendid than the first has just been discovered. It is a prolongation of the former and every thing in it is grand and magnificent. The various halls, if we may so call them, resemble the naves of cathedrals. On the right and left are stalagmites, rising in stages to a great weight, which look like glaciers, and extend further than the eye can reach. From the top of one of them, which is between sixty and seventy feet high, rushes a superb cascade, which falls into an alabaster basin, to which the name of Bath of the Nymphs has been given. Beyond this second grotto there is a third which will be explored next week. The persons who have discovered these caverns have already penetrated above a league into them.

Diamond.—The diamond is pure carbon, or charcoal crystallized. It is among the rarest of all known substances, and carbon is among the most abundant. We can have a roomful of pure carbon for sixpence, but a bit of pure crystallized carbon the size of half your thumb is worth many thousand pounds. You drink diamonds when you drink soda-water; but you drink them in the form of gas. Mr. Faraday has succeeded by immense pressure, in reducing carbon from the gaseous to the liquid state; but it must be kept in a glass tube, hermetically sealed. The moment it comes in contact with the atmosphere, it again assumes the gaseous form. Diamond require great heat to burn it; but, when it does burn, it consumes utterly. Its whole substance changes into that kind of gas which is pumped into soda-water, and is produced naturally in champagne.

Singular Discovery.—Arsenic in Candles.—At the meeting of the Medico-Botanical Society, Earl Stanhope in the chair, Mr. Everitt, the professor of chymistry, made some remarks respecting the tests for arsenic, and afterwards demonstrated its presence in the composition candles. Having fully proved the existence of the poison in the candle, in the proportion of at least two grains in each (and he stated his belief that four grains were a more correct statement), he then proceeded to assign a reason for its use. Candles which are made of tallow have too low a melting point to admit of the use of a curved wick. Sterine or spermaceti, either of which has a much higher melting point, is therefore employed in making the composition candles, and to prevent its running into grain or crystallizing, a certain quantity of wax was added, which it was found would fully answer the purpose. It was afterwards discovered that a small quantity of arsenic would effect the same object, and, it being considerably cheaper, it was adopted into use. The Professor further stated, that when he had made the discovery, and it had become bruited abroad, his opinions were confirmed by two or three manufacturers, who acknowledged using the poison. He left it to the members of the profession to determine whether arsenic thus volatilized, and coming in contact with the lungs, would prove deleterious. Judging from the effects of other gases, he thought it would be injurious.

DRY-ROT IN TIMBER.

Some very strong, and indeed conclusive evidence, in favour of the process adopted under Kyan's patent, for the prevention of the dry-rot in timber, and the decay of other substances, is afforded in a recent publication, not printed for sale, entitled "Papers on subjects connected with the Duties of the Corps of Royal Engineers," and intended to give energy to those duties, both military and civil, imposed upon officers in that branch of the service, and which are in some danger, owing to the long peace, of falling into neglect. One of these papers, prepared by Captain Alderson, of the Royal Engineers, is specially devoted to the consideration of Kyan's process, the extensive adoption of which he strongly recommends in his department. Permission was obtained, it seems, for the introduction of the process in the engineer department in September last, on the application of Lieutenant-Colonel Harding, who addressed a letter to Major-General Sir Frederick Mulcaster, Inspector-General of Fortifications, on this subject. In this letter he refers to an examination of some timber prepared by this process in 1834, and put up experimentally in the house of the Lieutenant-Governor, which was found perfectly sound, while some unprepared timber, put up at the same time, was much decayed. In other letters, which form an appendix to Captain Alderson's essay, further experiments are detailed, and a very striking one may be quoted from them, in which pieces of oak, ash, and elm, which came to the Royal Carriage-office in a green state, with the bark and some leaves upon them, were split down the middle and marked. Half of each specimen of the wood was returned to be saturated with the patent, and when sent back the whole were put down in March, 1835. These were taken up in September last, and at the end of a year and a half it was found that the prepared pieces, even to the preservation of the bark and sap, were perfectly sound, and the unprepared quite rotten. There seems ground for believing, on the statement of Captain Alderson, that this process will be found as effectual a safeguard against a principle of decay, that of the destructive attacks of the termite, or white ant, peculiar to tropical climates, as it is against that distinguished by the name of dry-rot. On account of the greater durability thus acquired for timber of all descriptions, he looks forward to the substitution in some cases of timber for masonry; in the coping of walls, for instance, of from one to four feet in thickness. He suggests that the decay of brick walls has arisen chiefly from the number of joints in the coping, whether of brick or of stone, as the cracks in the joints are seldom attended to till the effects of decay are visible in the wall itself. This substitution he conceives might take place with peculiar effect in our North American colonies, where pointing even with cement cannot be done with advantage more than three months in the year; also in tropical climates, where the rapidity of vegetation is visible in the joints of masonry, and destroys them in a very short time. Captain Alderson refers to the opinion of Professor Faraday on Kyan's process, as given in his lecture at the Royal Institution in February, 1833, and subjoins in a note his assurance that up to the present time Professor Faraday has seen no reason to alter his opinion of the efficacy of this process. Altogether the desideratum, so long sought, of a preventive for the dry-rot in timber, seems at last to have been found.

INDICATIONS OF COAL.

In a search of such great importance as the discovery of coal in any part of the country where collieries are far distant, the associates of coal, even those of most casual occurrence, are worth attending to. Salt, in various parts, is an associate of coal, although coals are not yet proved to underlie our great salt district of Cheshire. Basalt, or whinstone, though of common occurrence among the elder rocks, are known also to overlie chalk, is so commonly found in our northern parts, lying in the coal measures, and even upon the coal, that it must be considered a not unfrequent associate; and in the red rocks, either over or under the coal series, whinstone is, in Scotland, a near neighbour to the collieries; and, therefore, upon the principle of what occurs in one place may occur in another, the vicinity of whinstone rocks in certain localities may be worth searching. Places which are, also, in other respects not unfavourable, will, of course, be preferred. The vicinity of stone in Gloucestershire, and Thorverton, and Upton Pyne, in Devonshire, may be mentioned. Mountain limestone and millstone grit, the common underliers of coal, are also within a short distance of the former place; and it appears, by Mr. De la Beche's sections of Devonshire strata, which have been exhibited at the Bristol meeting of the British Association, and elsewhere, that the granite and the coal measures may be such near neighbours as to lie almost in contact. With such deviations from the order of superposition as opposite sides of the cross section of the Devonshire cavin in the strata, present how can the theory of "must have been formed level on the bed of the sea, and subsequently elevated or depressed," be applied to such inexplicable phenomena as in the two sides? What, on the Dartmoor side, either by the elevation of granite, or by the sinking of the superincumbent rocks, could have caused all in the series, between granite and the coal measures, to disappear? or, what could annihilate all those rocks which, on the opposite side, stare us in the face? But, to something more useful; by the help of this section, and the fossil vegetables served up on the table, which, at the feast of reason and common sense, would be coal measures; and that, not merely those next the granite, but the whole of the coal series, and the coal itself (now anthracite, or culm), may be, altogether, considered as "altered rocks:" and for the accuracy of this opinion, we have the analogy of experience on the opposite side of the Channel; of stone coal, or culm, easterly, becoming less and less culmiferous, and, finally, good coal; and why not so between the Bristol and English Channels? Unconformity in the upper strata prevents our seeing the easterly extension of the Danmonian cavin of coal measures, but judicious boring might prove it.—*W. Smith, LL.D.*

The Pyramids.—At a late meeting of the Royal Society of Literature two communications were read from Colonel Vyse, dated Cairo, April 20, and May 22. It appears that that gentleman had employed, for a considerable time, 300 men and children (Arabs) in clearing away sand and other obstructions, boring, and a variety of laborious and difficult works necessary to success in this arduous undertaking. The principal results of the expensive and persevering exertions of Colonel Vyse are the discovery of three new chambers in the great Pyramid, and the excavation of a remarkable mummy pit in its vicinity. The newly-opened chambers are all situated above each other, the first being immediately over that known as Davison's Chamber. An entrance to it was blasted on the 29th of March. The apartment is of the dimensions of thirty-eight feet six inches from east to west, and seventeen feet one inch from north to south. Colonel Vyse has denominated it the Wellington Chamber, and has had the illustrious name inscribed on its northern wall. It had certainly never been opened—a black dust, a specimen of which the Colonel has sent home to be analysed, was deposited on the floor, &c. The second chamber was named Nelson's; its size is thirty-eight feet nine inches by sixteen feet eight inches. The third, named after Lady Arbuthnot, who was on the spot at the time of its discovery, measures thirty-seven feet four inches by sixteen feet four inches. The height of all these chambers is variable. In each case the same blocks of granite form both the ceiling of the chamber below and the floor of that above. There are passages and *entresoi* between. The object of this succession of chambers, Colonel Vyse supposes to have been to lessen the superincumbent weight above the King's Chamber, the only apartment, in the proper sense of the term, in the Pyramid. At the date of dispatching his second letter, Colonel Vyse entertained sanguine expectations of discovering the *souterrain* in the second Pyramid, mentioned by Herodotus, as surrounded by the Nile. The tomb to which has been given the name of Colonel Campbell's Tomb, is a large square excavation, including in its centre an oblong building perfectly *arched*, of very fine masonry, which was found to contain a sarcophagus, some amphoræ, &c. Among some hieroglyphics inscribed on the side of the square is the cartouche of Psammeticus II.; and another arch of this kind, at Saccara, being mentioned by Mr. Wilkinson, the fact is established beyond doubt, that the arch was known in Egypt 600 years prior to our era. A great quantity of drawings has been sent home by Colonel Vyse, to be immediately engraved, including accurate sections of all the pyramids, *fac-similes* of hieroglyphics in the newly-discovered chambers, &c.

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The Mining Journal
AND COMMERCIAL GAZETTE.

SUPPLEMENT---XXI.

EWS.

After Thoughts on Reading Dr. Buckland's Bridgewater Treatise. By the Hon. and Rev. S. Best. Hatchard. London, 1837.

Remarks on Dr. Buckland's View of the Mosaic Creation, as the last Fitting up of the Earth, with a Notice of the Recorded Extent of the Deluge. By Eretzsepher. Smallfield. London, 1837.

Within the period of our recollection, no scientific work has appeared which has excited so much sensation among general readers, or has been subjected to such strong animadversion among certain classes, as the Bridgewater Treatise on "Geology and Mineralogy," by Dr. Buckland. Our own opinions were fully expressed in the copious notice of the work, which was given in this Journal shortly after its publication; and after reading the various criticisms it has since called forth, we have seen no reason to alter them, or to modify the views we then expressed.

It will be seen that the two pamphlets at the head of this article, are the offspring of Dr. Buckland's Treatise, and as they are intended to elucidate those theoretical views on which so much public interest has been excited, we propose fully to consider them on the present occasion, having for some time deferred our notice, from the pressure of other works of a more practical nature, and more immediately connected with the objects of our publication.

We need hardly observe, that both the pamphlets before us treat chiefly on the difficult and long agitated question, as to the agreement of the Mosaic narrative of Creation, with the discoveries of geological science—a subject which had long been slumbering, till the publication of Dr. Buckland's work had the effect of again provoking discussion, and exciting that interest which the importance of the subject is well calculated to command.

The inspired narrative of Creation has, from the earliest ages almost to the present time, been looked upon as containing the only record of that mighty exercise of Omnipotence by which

——"the heavens and earth
Rose out of chaos."

When the surface of our planet was moulded to its present state, the various forms of animated existence called into being, and man himself created to "have dominion" over all around him. To this manifestation of Divine power, the lapse of six days is assigned by Moses, and to this period the institution of the Sabbath is traced. Commencing from the "beginning," when "God created the heavens and the earth," the Scripture narrative traces the progress, first of the human race generally, and then of one particular and favoured branch, down to periods comparatively recent, and within the range of authentic and contemporary history—thus affording a standard of chronology from the very first existence of mankind—a result which had otherwise been wholly unattainable. Keeping constantly in view its one great object, the dispensations of Divine Providence towards the human race, the Sacred History touches not on the physical structure of the globe, except briefly to ascribe its origin and that of organic being to Creative power, nor notices the changes which may have taken place upon its surface, with the exception of a single instance, in which the universal destruction of mankind was effected by a great physical revolution—by that tremendous catastrophe, termed emphatically the "Deluge," of which, by a remarkable coincidence, almost every nation has retained some tradition of its own.

The brief and precious record, invaluable as regards its antiquity alone (setting aside all other considerations), which contained exclusively this incidental notice of physical facts, was received by succeeding generations with the fullest confidence in its strictest and most literal interpretation, and all natural phenomena connected with structure of the earth's surface were readily and unhesitatingly explained by reference to the narrative of Moses, without the slightest doubt ever being entertained that this generalization, so hasty and gratuitous, as we now find it to be, was correct, or that these phenomena could ever be brought to the test of observation, and placed within the limits of inductive science.

It is not surprising that feelings so deeply rooted, and connected also with the grounds of religious belief, should have received a severe shock, when about half a century ago, attention was first directed to the internal structure of the earth, and indications were there perceived of change, of revolution, and of lapse of time, which were totally at variance with all pre-conceived ideas. Hence it was that the earlier cultivators of geology were exposed to the taunts of irreligion, and the science itself considered by many to be subversive of the best interests of man, and hence those feelings of animosity arose, which, although dormant for a time, have not failed to be excited, in some quarters, by the appearance of Dr. Buckland's work—although we perceive with pleasure that in the two pamphlets before us, both written by men of education and learning, whatever other defects may exist, no trace of this unworthy spirit is apparent.

To those who possess any knowledge of geology, we need hardly say, that although far from being perfect as a science, still many of its first and most important principles are established as firmly, and rest upon evidence as decisive as those of any other branch of human knowledge. In discussing a subject like the one before us, this fact should be kept in mind, and a clear distinction should be made between the positive and ascertained principles, and the yet incomplete deductions of the science. To borrow illustrations from cases somewhat analogous, fluxions were not invented till many centuries after Euclid had written his treatise on Geometry; but his demonstrations are not called in question, because he was unacquainted with this higher and more refined branch of analysis. The existence of a resisting medium in space was a matter of speculation at the time when Newton ascertained the laws of gravitation, but his great discoveries are not vitiated on that account. In the same manner, we would observe, the admitted facts and deductions of geology, are not to be received with distrust, nor is there any probability they will be hereafter overturned, because parts of the science are yet veiled in obscurity.

We are ready to admit, that considerable difficulty exists in perfectly reconciling the history of Creation, as given by Moses, with those records of this great event, which Nature has preserved for our examination. Perhaps the true reason is, that we are not yet perfectly acquainted with the language in which either is written, and while the geologist must acknowledge that he has not yet wholly deciphered the hieroglyphics of Nature, the Biblical critic ought to confess that the received interpretation of the brief passages of Scripture referred to, may yet be capable of further elucidation, and that the often obscure and figurative language of the earliest history extant, should not, as too frequently has been the case, be rashly brought into collision with the discoveries of science. One thing at least is clear, that none ought to enter this difficult field unless thoroughly qualified for the task, by a perfect acquaintance with all the facts of the case, and that by a contrary mode of proceeding, the only result will be "to darken counsel by words without knowledge," and to render hopeless and impracticable that which is manifestly obscure and difficult.

Entertaining these views, and looking at the subject not theoretically only, but with that confidence which results from a long and practical acquaintance with geological phenomena, we shall now proceed to examine Mr. Best's pamphlet, and to consider how far the "After Thoughts" with which he has favoured the world, will be found consistent with admitted facts, and decisive of the theory which he is desirous of establishing. We cannot, perhaps, better explain the views of the author than by extracting the following introductory passages:—

"The 'Bridgewater Treatises' appear to have produced such great effects as will lead others, let us hope, to imitate the example of their noble founder. The part which has been assigned, and so ably executed by Dr. Buckland, from its connexion with subjects of high interest, will receive the greatest attention. The effect of this particular treatise it seems difficult to estimate, but certain it is, that it has roused the dormant feelings and energies of persons entertaining different opinions, and made no small stir among the thinking classes of the reading public. Considering the question as a Christian, it derives its first importance and interest from the views it induces of the Mosaic cosmogony. It may be highly interesting in its details; it may afford the most convincing testimony of the goodness of God, as displayed in the minutest as well as the greatest labours of his creation; it may afford irrefragable proofs in attestation of natural theology, but the anxious question of the Christian will be—How does it accord with the Sacred Writings? By the scientific world, Dr. Buckland is found fault with for mixing up theology with science, and for not treating the subject as an abstract question; by a large part of the religious world he is condemned as introducing dangerous innovations, and shaking our faith without satisfying the doubts his investigations have suggested. With deference to both these bodies, and without being an apologist of Dr. Buckland, as the sequel will show, how was it possible for him to execute his task without taking the course he has? How was it possible for him to treat of the origin and ancient condition of the earth we inhabit, without alluding to the only authorised account we have of its coming into being? How could he write a treatise on geology as affording proofs in attestation of natural religion, and confine it to a mere detail of facts without inferences, or to such inferences only as should not interfere with or allude to the Mosaic accounts? On the other hand, would the religious world, with these facts made the ground-work of his inquiries, have wished him to have stated them without any endeavour to reconcile them with those accounts which we revere? Let both parties consider how, under the circumstances, it were possible to treat of the question at all without pursuing the course Dr. Buckland has followed, that of reconciling the discoveries of science with the knowledge revealed to us from an unerring source. The holiest labour in which a theologian can now employ himself is in pointing out the accordance between each rising discovery in science and the holy records of our faith; there is no error so dangerous as that which opposes science to revelation, there is no weakness so lamentable in the Christian as the admission that there is ground for fear. What is his true position? Not one of diffidence or reluctance to advance into the fields of science, but to go in boldly with the sickle, and to claim the field as his own. That which has been revealed by God cannot but be truth; the discoveries of man must be in accordance with it, or though they may last as bubbles of a day, and, on partial facts, appear to have some colour of reason, they will fall, as have theories on theories, before the steady light of revelation. Dr. Buckland admirably prefaces his investigations by showing how far we are to look in the Bible for scientific truth; how far such revelations would be consistent with the purposes for which that wonderful Book was given to men; he shows us how absurd is the expectation that in the Bible we should find revelations of science;—were all things told us, where should we find a proper exercise for those faculties with which we are endowed, and whose enlargement is, perhaps, one of the means by which, in a future state, we are to be in a capacity of enjoyment? or were the Bible encumbered with the dry and abstract truths of science, how inapplicable would it be to the comprehension and instruction of the young? To the Bible then it is idle to look for the revelation of scientific truths, but by one extraordinary characteristic it is distinguished. To accommodate itself to its first great object, the instruction of mankind, it speaks in the several languages, or to the several understandings, of those it addresses; but it never contradicts truth—its pure philosophy is in perfect accordance with every established discovery. Thousands of years have revolved since Moses wrote, the most enlightened nations have sprung up and decayed—science has slowly but steadily advanced, but whatever be its advances this wonderful volume has always kept up with them. The idle theories of men, who from a single fact often build a system or lay down a rule, have been often in opposition: but where are they? the crucible of time has tried them, and preserved only the small portion they contained of truth, and that truth is, as it ever must be, in accordance with, and a powerful evidence to, the scriptures. Entering fully into the views of Dr. Buckland, admiring the spirit in which he writes, and deprecating all fears as unworthy of the Christian as to the result of inquiries, there is still an important step which we cannot take, that of going boldly forward with him in his theory. To so learned a man, entertaining such enlightened and truly Christian views, we can willingly say, 'God speed;' but we do not feel, after an attentive perusal of his highly interesting and learned treatise, that we are prepared to throw overboard all our preconceived notions, or that the positions he has assumed are so strong and impregnable, that we must bend to them the views we have been taught from our childhood to entertain. I will endeavour to give a few of the reasons why I do not throw myself into the arms of Dr. Buckland's theory, not from entertaining any opposing theory, but from what would appear the insufficiency of his. In preparing to defend with more efficient batteries our venerable citadel, and to bring the later discoveries of science to bear on its defence, it is necessary for Dr. Buckland to remove or repair the existing outworks; and he does this with judgment and a respectful reverence; he confines his views and alterations to the interpretation which has been placed on the sacred text, which has become venerable only by years."

Coinciding as we do with the just and liberal sentiments expressed in these passages, we regret to be under the necessity of widely dissenting from nearly all which follows. Passing over the question, as to whether any previous creation, or habitable state of the world, preceded that described by Moses, we have the following enunciation of the author's theory:—

"Our simple theory is well known. The Creation is our beginning of the geologist; the Deluge and the operation of the ordinary powers and forces we see still at work, the machinery by which all the geological revolutions and effects have been completed; and after a careful examination of Dr. Buckland's theory, it does not still appear but what all his phenomena are reconcilable with this."

With reference to the geological antiquity assigned to the world by Dr. Buckland, in common with other geologists, Mr. Best proceeds to observe—

"Throughout his work there appears a vague presupposition of his inquiries extending almost into eternity; and we can pardon the philosopher who first opening the volume of nature which he has taken up, allows his imagination to run away with his judgment—the magnificent discoveries that are developed, the wonderful nature of the things discovered, and the peculiar state in which they are discovered, would easily lead away an ethusiastic devotee. We are prepared for this pre-supposed antiquity of the world, which, as already stated, appears a key to the whole theory in the preface, where 'our planet is spoken of as occupied, in times preceding the creation of man, by extinct species of animals and vegetables.' As it is this part of the theory we are disposed to combat, it will be necessary to keep it more immediately in view."

We shall now proceed to examine some of the arguments which Mr. Best brings forward to support his views, candidly stating, however, that he "relies on no geological knowledge of his own," a fact of which he certainly exhibits abundant proof:—

"Let it be remarked in the first instance, and the remark should be kept in view in the perusal of the whole of Dr. Buckland's treatise, that none of his investigations appear to have respect to those countries which were the cradle of the human race, which were the scenes of history, and the residence of God's creation, as related by Moses. In endeavouring to discover whether man, as Moses appears to us to say, was cotemporary with God's first creation, our investigations should be made in Asia, on the plain of Shinar, and on the banks of the Euphrates, not in the limestone of Paris or Germany, or of our own hills. On the contrary, however, the principal geological investigations have respect to countries in the early ages of the world uninhabited by man. In these wilds we may very easily imagine, for wise and admirable purposes, perhaps to prepare them for the habitation of man, such monstrous species as the Saurian may have for centuries predominated, perhaps they alone were calculated to exist in the then raw and unsettled state of the material world, and having fulfilled their purpose, became extinct, as we know other monsters have; let this, however, pass as speculation, they would at least retreat and diminish in number before man, and could hardly, therefore, be found mixed up with species and races adapted to a more civilised state."

The first part of these remarks carries sufficient plausibility to require refutation. It is true that Asia and the earlier seats of the human race have for a long while received comparatively little attention from geologists. Very recently, however, some of these countries have been examined by our countrymen, Messrs. Strickland and Hamilton, and also by French geologists of eminence, but their researches have *not* led to any discovery of human remains or works of art "cotemporary with God's first creation;" nor have they shown, or even given reason to suppose, that there exists any essential deviation whatever in the structure or fossil remains of these countries, from the types before established by observations in other parts of the world. The probability of the Saurian species, or similar monsters, having been contemporary with man, as we shall show hereafter, is perfectly untenable, and could only have been suggested by a deplorable ignorance of geological facts.

To account for the absence of human remains, a point, be it remembered, of the utmost importance as connected with the views which he propounds, the author proceeds—

"With respect to human remains and those of animals or vegetables fitted for food, their absence, if such an absence there is in countries where it is probable they would be found, may be partly, if not wholly accounted for, as regards human remains, by the practice of consuming the body by fire."

The explanation here brought forward is peculiarly unhappy; for we have no reason whatever to believe that the "practice of consuming the body by fire," was customary among the most ancient races of mankind—on the contrary, the earliest funeral rites recorded in Scripture are those of *burial*. "And Abraham *buried* Sarah his wife in the cave of the field of Machpelah" (Gen. xxiii. 19). That the custom of burial was then generally practiced by mankind is proved by Abraham purchasing this cave for his family burial place with great form, and also by the "children of Heth," among whom he dwelt, declaring "*in the choice of our sepulchres, bury thy dead*" (Gen. xxiii. 6). When Isaac died, "his sons Esau and Jacob *buried* him" (Gen. xxxv. 29); and the sons of Jacob "*buried* him in the cave of the field of Machpelah" (Gen. l. 13). When Moses died, we are told that "he" (the Lord) "*buried* him in a valley in the land of Moab," but "no man knoweth of his *sepulchre* unto this day" (Deut. xxxiv. 6). In the excavated city of Petra, the stronghold of Edom, many of the chambers hewn in the rock were evidently intended as places of burial, and have been considered as such by all travellers who have visited this remarkable relic of antiquity. To multiply proofs so abundant as might be cited in proof of the high antiquity of burial, and the consequent futility of the above argument would be almost superfluous; yet we would further observe, that the Egyptians, the most ancient nation with whose customs we have any intimate acquaintance, so far from "consuming the body by fire," preserved it with the utmost care by the process of embalming, as we see by the mummies which are to be found in almost every collection of antiquities. How the hon. and rev. author could have brought forward an argument on this important subject so weak, so futile, and so contrary to historical facts, we are totally at a loss to conceive.

On the supposed contemporaneous existence of fossil animals with man, we have the following remarks:—

"If these monsters, whether Saurians, or Pterodactyles, or Megatheria, or by whatever arbitrary name they may be called, existed at the same time with man, it may be asked, How is it there is no tradition of it? we might answer this by another question: Is there no tradition of it? What are all the monsters of antiquity which have been hitherto looked upon as fabulous, and which men were deified for destroying? what were all the wonders of Hercules and his cotemporaries? will these throw no light on the gigantic and monstrous races of the primeval world? We have imagined these monsters retreating before human civilisation, and, in accordance with this, we find that it was the first inhabitants of Greece and the Isles of the Gentiles, as they are called in Holy Writ, who met with, and immortalized themselves by the destruction of these monsters of the waste. To the same fact the scriptures themselves appear to allude, or at least, to what, on our supposition, is almost the same, to the extinction of gigantic races that did once exist. Where now is the leviathan and mammoth? or where, it may perhaps be asked, in

the same spirit, is the fish that swallowed Jonah? These, at least, among many other instances derived from sacred or profane history, may be adduced to show that tradition is in favour of such monsters having once existed with man; and our own experience will always teach us why their remains would not be found together, in the numerous races that are becoming daily extinct, as far as different localities are concerned, and in the habitual retreat of the wilder and fiercer animals, both birds and beasts, before the footsteps of man."

To expose the full absurdity of this reasoning, would occupy a much greater space than we can well devote; we shall, therefore, briefly observe, that the strata which contain the remains of Saurians and Pterodactyles (the lias and oolites) are covered by others, many thousand feet in thickness, containing many different and successive varieties of animal remains, chiefly accumulated at the bottom of the ocean, proving that great revolutions of the earth's surface, and a vast interval of time must have elapsed since the existence of the former. During these great revolutions, and this general preponderance of the ocean, the contemporaneous existence of man, and "these monsters retreating before human civilization," are manifestly ideas so absurd, that they could only have been entertained in consequence of complete ignorance of the facts of the case. It is well known that even the fœces of the Saurian tribe are preserved, forming the singular fossil bodies called *coprolites*, which still exhibit, in a very perfect state, even the *food which these animals devoured*. If man were contemporaneous with them, as the author supposes, how does it happen that not a single trace of *his* remains, or of the works of human art, have been preserved, together with these remarkable and unlooked-for records of his supposed cotemporaries?

With reference to the sole occupancy of the globe by the animal creation for periods long antecedent to the creation of man, we have the following remarks:—

"To commence with the Creation, both of Moses and Dr. Buckland, that part of the theory which, as another stumbling-block in the way of infidelity, has afforded me the sincerest pleasure, 'In the beginning God created the heavens and the earth; and the earth was without form and void, and darkness was upon the face of the deep: and the Spirit of God moved upon the face of the waters.' Between this and the third verse in which Moses proceeds to relate the creation of those things we see around us, Dr. Buckland interposes a lapse of cycles and periods, in which first the primary strata were deposited, then those in which are found the bones of monsters of various kinds; and this he supposes probably to have been the work of several creations, until we come to that one in which Moses tells us God breathed into 'man's nostrils the breath of life, and he became a living soul.' I would not unduly exalt the nature of man, but how does this lower the value of intelligence, if we suppose worlds thus to be created for the sole occupancy of brutes without reason, or that any part of God's creation could have for millions of years existed without reference to his service?"

The force of this reasoning will best be illustrated by reference to the present state and occupancy of the globe: nearly three-fourths of its surface is covered by water—from the remaining fourth, deduct the arid uninhabitable desert, the impenetrable forest, the rocky waste, the elevated and often snow-clad mountain, and how small a portion we shall find is actually tenanted by the human race even in the present state of things, with a population far exceeding that of any former period, although we can hardly find a spot in which the animal creation does not exist.

Of the very incorrect and confused ideas entertained by the author with respect to some of the phenomena on which he presumes to argue, we have some curious illustrations in the following passages:—

"But to return to the argument. Supposing the world, in an incandescent state, and cooling gradually to adapt itself to the habitation of God's creatures, it will be well worth inquiry, whether in so cooling from a fluid into a solid state, the probable, nay, natural result would not be that the cooled mass would be found in different strata? Subjecting such a mass of different bodies and substances as compose the world, to intense heat, would it not settle down in much the same state in which the primary strata are found? and if so, may we not curtail the time that the geologist, in his enthusiasm for the novel wonders he has discovered, describes as necessary to form these depositions? Dr. Buckland calls to his aid five forces as the origin of geological phenomena; now three of these, intense heat, violent inundations, and volcanos, would be amply sufficient to account for everything. But we have no need of a new theory to illustrate this. Dr. Buckland, as above, furnishes us with intense heat, the Bible furnishes us with a violent inundation, and experience furnishes us with volcanos. All of these are miracles in nature; and when we resort to miracles it is difficult to lay down rules for our guidance in judging their effects. We are told that in the earlier strata there are no remains; having been told of the gradual cooling of an incandescent mass, we should not expect to find them, nor on the supposition that these strata are the effects of that cooling is it possible they could exist. All those strata in which are found no organic remains, I should ascribe to the same period, the beginning, when the cooling mass deposed itself in strata, the different compositions according to their weight, their character, or attributes, deposing themselves on the subsidence of the heat."

The hypothesis here propounded is novel in the extreme; we are accustomed to look upon all *stratified* deposits as formed by the action of *water*, and upon *unstratified* rocks as the products of *subterranean heat*, but the author, for some reason which he does not explain, has adopted quite a contrary theory, considering, as a "natural result," from the earth having been originally in a state of fusion, that "the cooled mass would be found in different strata," and "that the *cooling mass deposed itself in strata*," "the strata being the effects of that cooling." The coincidence of this new theory with geological facts, we leave others to inquire. To the assertion of geological causes, indeed of the *whole range of natural phenomena* being, in the widest sense of the word, miracles, we readily assent, for, as Cowper has well expressed it,

"All we behold, is miracle;"

but (and we say it with reverence) as all the phenomena with which the geologist has to deal have evidently been similar to, and in strict accordance with, the present laws and operations of Nature, we can by no means assent to the doctrine hence propounded, that "it is difficult (*impossible* seems to be intended) to lay down rules for our guidance in judging of their effects."

To follow the author closely through the rest of his work, and to combat one by one the arguments derived from crude and imperfect knowledge which he has brought to bear upon the subject, would be, we conceive, a superfluous task—one or two more examples will be amply sufficient. The long-exploded idea of the earth's axis having been changed, and thus accounting for the former high temperature of the temperate and polar regions, is thus brought forward:—

"In the discoveries of geology we find that there certainly was a time when the temperature of the different climes was not what it now is; had the inclination of the pole been different, a difference in the climates must have been a consequence. Combining these facts, may it be permitted to return to an exploded theory, and ask whether it is possible that a change in the inclination of the pole at any time, perhaps the time of the deluge, could have effected this, or be sufficient to account for what we observe; or by what impulse may the currents of the mighty waters have had a northward direction given to them, and have borne with them the productions of milder climes?"

The idea of a change having taken place in the position of the earth's axis, was certainly at one time plausible enough; and it is not at all surprising that it should have been entertained. When, however, the question is asked at the present day, "whether it may be permitted to return to this exploded theory?" we may decidedly answer in the negative, as further researches on this interesting subject have shown that such a change is in the highest degree improbable—we might say, indeed more—could not have taken place. The figure of the earth being, as is now well ascertained, a spheroid of rotation, and the remarkable fact of a symmetrical arrangement of its internal masses of equal density, which has been inferred from certain lunar irregularities, at once forbid us to return to any such gratuitous hypothesis.

The chimerical theory which has been so often propounded to account for tropical plants being found imbedded in the strata, in high latitudes, that they have been borne from "milder climes" by diluvial currents, may at once be dispelled by an examination of these fossil remains. Although organic matter has generally disappeared, the impressions, so delicate and so beautiful, as to exhibit the minutest fibres and cortical markings of the original plant, *preserved almost as perfectly as impressions on sealing-wax*, prove that they must have grown on or near the spot where they are now found, and render the idea of drifting thousands of miles from tropical climates quite absurd. Let us, however, contrast with this perfect preservation, the undoubted effects of diluvial currents, as exhibited in various geological phenomena, and we shall find that by this action, masses of the hardest rocks of granite, porphyry, and sandstone, are in innumerable cases worn smooth, and rounded by attrition. Can evidence stronger and more complete be required?

Mr. Best labours to prove that the various strata composing the earth's crust have been of very rapid, instead of very gradual formation:—

"While on limestone, Dr. Buckland admits that in tropical climates stone is formed in a few years from sand-banks with fragments of shell and coral; we would ask him whether he supposes this the effect of heat, if so, considerable light might be thrown on the general formation of strata in accordance with the theory before ventured, as to the origin and subsidence of the intense heat of matter. Again he says that so similar is the succession of beds of sandstone clay and limestone repeated irregularly, that similarity of composition is but an uncertain proof of contemporaneous origin: the surest test of identity of time is afforded in the correspondence of organic remains, without these, the proofs of the lapse of the long periods assigned by geology would be few and incomplete; is not here the whole argument from strata given up."

On this hasty generalisation we shall offer but few remarks, for the evidence of the gradual formation of some, indeed of most, strata is quite as decisive as that of the occasionally rapid formation of others. In most mountainous parts of the world gneiss is a very abundant rock, often occurring in strata which are thousands of feet in thickness. Gneiss generally rests upon granite, for which it would easily be mistaken by an unpracticed eye, as it is in fact composed of precisely the same mineral ingredients, and often in a very similar state of aggregation; when, however, we examine it minutely, it is evident that the crystalline particles which compose this rock have undergone some mechanical movement, as their exterior edges and angles are generally, although in a slight degree, rounded and worn away. Hence gneiss may be considered, in fact, as a fragmentary rock, as a vast accumulation of granitic detritus slightly worn and reconsolidated again. Surely, in this prodigious wear of a rock so hard as granite, and that by an agent so tranquil as scarcely to obliterate the crystalline texture of the particles, yet so long continued as to have produced strata some thousands of feet in thickness, we have the most perfect and convincing evidence of a slow and gradual formation, and that without any reference to organic remains, although, as Dr. Buckland justly observes, they form one of the strongest proofs of the lapse of time.

One more example and we have done. The beautiful results of comparative anatomy—the labours of Cuvier, of Buckland, and others, and the demonstrations founded upon them, are, by a short and cogent piece of reasoning, at once nullified and destroyed.

"The Sloth we are told deviates by an anomalous formation from the ordinary structure of animals. Now if such a deviation exists before our eyes, let us not be too sure that in putting together the bones of extinct species and in defining their habits and nature, we are not out of collected fossil remains creating to ourselves a monster. We do not say such is the case, but here again is another instance of uncertainty and imperfection in our knowledge; comparative anatomy is our only guide in such researches, if that is set at nought in the Sloth and other animals, what certainty can we have in the monstrous Saurian, the Megatherium, Pterodactyle, or hoc genus omne."

We had marked other passages for examination, but as they are all of a very similar character, we forbear further extract or observation. That the zeal of the author should so far have outrun his discretion, as to present to the world such a specimen of crude and incongruous reasoning upon a subject so important, and which he has so evidently at heart, is a circumstance at which we cannot feel otherwise than surprised. To the unscientific reader, the arguments adduced, coinciding as they do with the general preconceived ideas on the subject, may doubtless appear convincing enough; and for this reason we have exposed their fallacy at greater length than we should otherwise have done. The truths of science and the truths of revelation, notwithstanding partial and seeming discrepancies, can have in reality nothing to fear from each other, and the weakness which thus inefficiently brings them in collision, can only be productive of mischief and error.

We now proceed to the second work at the head of this article, "Remarks on Dr. Buckland's View of the Mosaic Creation, as the last Fitting up of the Earth;" and on a work chiefly occupied by a critical and elaborate examination and comparison of the original Hebrew texts, our observations need be only brief.

The author states at the commencement—

"Dr. Buckland has advanced, in his 'Bridgewater Treatise,' a rather new and somewhat startling explanation of the events detailed in the first chapter of Genesis. It is, that we have there no original relation whatever, of the creation or production either of the animal or of the vegetable kingdom of the earth, but merely a notice that the earth was created, followed by an account of the last, and geologically very recent, renewal of it, after the lapse of ages of indefinite duration."

Dissenting from this theory, the author endeavours to prove that

"All the previous transactions related in the history took place in a period of time which, however it might have been divided in its details, was but *one period*, and consequently that they formed *one consecutive series*."

On the arguments adduced by the author, from a learned examination of the Hebrew text, we do not pretend to form a judgment—they are capable of examination by the Hebrew scholar alone, and that examination they will doubtless receive, as they appear to us to be able and deserving of attentive consideration. Passing over, therefore, much of the author's reasoning on this subject, we extract the following remarks, in the justice of some of which we fully concur:—

"To any who may consider that the construction above given of the days of creation, has too free a character, and who adhere to a literal closeness of interpretation, I must beg to repeat—remember the high antiquity of the transactions of the narrative and of its language, with no other contemporary record as a guide; consider the peculiarities of the terms I have attempted to point out, and whether there are not far greater difficulties, with nothing to remove them, in the way of their more literal construction, and then in what manner they can adapt a period beginning with the evening, and extending through the night, in strictness only to the opening of the morning, to so much as the first day, when it was said 'let there be light,' &c. They cannot avoid the contradiction that light was formed in the night, and that night did not cease on its formation, without supposing that it was not the work of the twenty-four hours, but that the command and the execution of it were postponed until the morning. So of the production of the sun on the fourth day. If the sun were already created, it was still night, with the sun appearing, or the evening and the night succeeding, it had little connexion with the matter. And so of the creation of the vegetable and animal kingdom. All ought, in this strictness of literal rendering, to have chiefly happened in the night, and man and the creatures of the sixth day should, for the greater part at least, have made their first appearance on earth amidst surrounding gloom.

"And here I must revert to the particular theory in the learned work before us, to observe, as a further bar to its claims, that all the remarkable coincidences between the Mosaic narrative of the creation and the meteorological causes which would then, in the course of nature, have been in operation, apply not at all, if the events took place in some modern period of six days. The seemingly sure concatenation of cause and effect has no real existence, and the correspondence here in the lessons of Nature and of Scripture, occurs only to lead us astray.

"Debts are often paid by very graceless returns, but I hope it will not be thought, that in any of the foregoing observations, I have been too little sensible of the high obligations which science owes the distinguished author. No science has so many enemies as geology. The youth of all sciences has been a season of persecution, but as their day advanced, the old struggle between light and darkness gradually sank to nothing. Since this is founded on fact, and truth, open and accessible to most, we do not best favour another great branch of truth, by striving to place the two in collision, but rather by showing how well they may grow and flourish together."

The concluding pages of the work, in which the author endeavours to prove that the Mosaic deluge was not universal, are ably written, and as far as we can pretend to judge, the line of argument is forcible and convincing.

The following passage briefly explains the author's view on the subject:—

"The purpose was the destruction, with the exception of Noah and his family, of all mankind for their evil conduct. That of every other living thing does not seem to have been a leading object, but rather incidental to the manner of it, for the inhabitants of the sea were not included, and all were alike connected with man by having been placed under his rule. Assuming the human race to have been, as I think the history bespeaks, of a number far from great, inhabiting, probably, some part of Lower Asia, the involving of the vast circuit of the globe in one common ruin, for the accomplishment of this limited design, does not seem to present that true adaptation of the means to the end, which is observable in all the other operations of the Author of the work."

How far the author has been successful in establishing the views which he propounds, we leave to be determined by those who are conversant with the original language of Scripture; but we consider that his able pamphlet must eventually be of service to the cause of truth, by setting an example of patiently endeavouring to elucidate, by comparison with parallel texts, the brief and obscure passages in which the Mosaic narrative of physical events is conveyed.

The Railway Magazine and Annals of Science. Edited by JOHN HERAPATH, Esq. No. XVIII. August, 1837. Wyld, Charing-cross.

The present Number of the "Railway Magazine" contains some interesting matter, and a good deal of practical information on levelling, refraction, use of the compass, &c., by the Editor.

We extract from the miscellaneous intelligence, the following short article, on metallic coverings for roofs of buildings:—

"A commission of the members of the Academy of Sciences has lately been sitting for the purpose of inquiring into the best covering for the cathedral at Chartres. They have reported and decide against the use of lead, because of its weight, the necessity for frequent repairs, and the danger to the men from its melting in case of fire. Though iron plate is successfully employed in Russia for coverings, they do not think it would suit the climate of France, on account of the expense of maintaining it. The commission had a considerable leaning towards recommending iron plates tinned, because of a new process with this metal by M. Sorel, which enables it successfully to resist oxidation, even when under the influence of more active agents than air and humidity; but they thought the proofs had not been sufficiently long to justify their recommending it for public buildings. After considering at some length the rival merits of copper and zinc, they decided in favour of the latter; first, on account of the expense, which would be about two-thirds that of copper; and, secondly, because an experience of above twenty years has shown that when the superficies of zinc is oxidised to an insensible depth, the thin film of oxide adheres so closely to the subjacent metal, as to become a sort of a preserving coat to it, and oppose the progress of alteration. There were some objections to the employment of zinc by reason of its great combustibility at very high temperatures, and the commission rejects it whenever wooden rafters were employed, but the cathedral in question having iron rafters, alters the case. They recommend the zinc plates to be simply fastened with clasps, for the purpose of allowing the utmost freedom to contraction and expansion on account of changes in the temperature, and to avoid any contact with plaster or calcareous mortars, which rapidly corrode it."

Among the miscellanea we find a short notice of the American experiments for producing rotatory motion, applicable to machinery, by the agency of electro-magnetism. What can our engineers and machinists be about? We do not hear of any of them being engaged in investigating the capabilities of this novel and promising source of mechanical power, which, from all that we know of it, is highly deserving of attention.

The American Journal of Science and Arts. Conducted by BENJAMIN SILLIMAN, M.D., LL.D., &c. &c. &c. Vol. XXXI. (for the last six months of 1836). Maltby, Herrick, and Noyes, New Haven. 1837.

[Concluding notice.]

The pressure of other matter has not, on former occasions, allowed us sufficient space for the extracts, which we had marked in the present volume, of Professor Silliman's Journal, and we therefore return to it again, for the purpose of introducing two interesting papers, to which we have previously referred—"Remarks on the Geology of New York," by Mr. Hayes, and "On Zinc, as a Covering for Buildings," by Professor Caswell.

Mr. Hayes modestly appears in the character of a *learner* only; the following are the introductory passages of this paper:—

"Geologists seem to have regarded the western counties of New York as a secondary region. The horizontal position of the strata, the salt springs and beds of gypsum, the evolution of carburetted hydrogen from the rocks in various places, and the entire absence of all trap rocks, are circumstances which would naturally direct the attention of geologists that way. With some, they have been considered sufficient evidence to establish the secondary character of the whole region; while a late writer in this Journal has supposed all these horizontal strata equivalent to the formation containing the lias of Europe. To me it would seem that the correctness of these opinions

may well be doubted. From the few examinations I have been able to make, as well as from the published descriptions of Professor Eaton and others, I cannot resist the conclusion, that all these rocks are older than the secondary formation, and owe their origin to that train of causes, whatever they were, that produced the transition rocks.

"The metalliferous limestone of Eaton, which occurs at Trenton Falls, and extends to the east end of Lake Ontario, seems to be well characterized as the *lower* transition limestone. It contains several species of the trilobite family, and other characteristic fossils. It passes under greywacke on the south, which, in its turn, is overlaid by a conglomerate rock, or millstone grit. Then comes the saliferous rock, so important to the economy and commerce of this State, overlaying the millstone grit, and by its northern outcrop, forming the southern shore of Lake Ontario. If the views here entertained are correct, this saliferous rock must be considered equivalent to the *old* red sandstone of European writers; separating as it does through its whole extent, the lower from the upper transition limestone. Wherever I have had an opportunity of examining its strata, they have an evident dip towards the south. In structure, it varies from a fine grained sandstone to a soft shale or slate; and in colour, from red to a dull green. Although it forms the floor of the salt springs at Onondaga and several other places further west, I see no reason to conclude that this rock contains the mineral salt itself, or that it is the only source from which it is derived. But from the fact that brackish springs, or "licks," as they are called in the western country, issue from some of the superincumbent strata, I should conclude that it acts as a vast reservoir—collecting the water which has become impregnated with the salt in passing through some of the superior formations. In Ohio and Pennsylvania, the saliferous rocks underlay the bituminous coal formations. Their general dip there also is towards the south, or south-west, while at some places they are pierced, by boring at a depth below the present surface of the ocean. The thought has often struck me (and I see nothing improbable in the supposition), that the saliferous rocks in Ohio, Pennsylvania, and New York, belong to one vast, continuous formation, having its northerly termination and outcrop in the latter State, on the shore of Lake Ontario.

"Lying upon this sandstone, or separated from it by shale, containing layers of argillaceous iron ore, is that vast calcareous formation, which presents so conspicuous a feature in the geology of this district. It extends through the western part of this State, having its northern outcrop and termination nearly parallel to that of the sandstone beneath, forming the mountain ridge through which the canal is excavated at Lockport, the upper portion of the precipice at the falls of Niagara, and the bed of that river from those falls to Buffalo. How far it forms the bed of Lake Erie cannot be well ascertained. Lying on the saliferous sandstone conformably, it dips in the same direction. At Queenstown heights, the geodiferous portion of this rock attains an elevation of ninety feet higher than the level of table rocks at the falls, six miles above, where it passes under the cherty or cornitiferous strata. This latter portion forms the rapids above the falls, by the water passing over the basseting edges of its strata. At Black Rock it rises twenty or thirty feet above the surface of the river, but declining towards the south, it disappears below the surface of Lake Erie, eight miles south of Buffalo; at which place it passes under shale or greywacke slate, and is not again seen rising above the water's surface. The eastern shore of Lake Erie is nearly or quite destitute of limestone till we get into the vicinity of Sandusky. The specimens from that place present a far different appearance from any that occur in this region, and I have no doubt, belong to a more recent formation. One specimen in my possession is decidedly oolitic. By following the Niagara River from Lewiston to the Falls, at the water's edge, the stratification can be examined to great advantage, and on a larger scale than at any other place. The general dip to the south is there very perceptible."

The author proceeds to remark on the similarity of this formation with the mountain limestone of Europe, but to us the most interesting part of the paper is that which describes the spontaneous evolution of carburetted hydrogen from the carboniferous shale of this district, and the uses to which it is applied.

The rock from which the gas issues is thus described:—

"The lower portion of these strata, where seems to commence the change from the transition to the coal formation, are mostly composed of soft shale or slate, sometimes bituminous, and containing large quantities of iron pyrites. This shale alternates with strata of impure limestone from one inch to one foot in thickness, which also contain iron pyrites disseminated and forming a thick coating on their under surface. The lower portion of this shale contains more or less carbonate of lime, varying from the least perceptible quantity to one half or more of its weight; constituting a marl of great value for agricultural purposes. It is principally in this marly state that the fossil shells occur. Many of the bivalves are exceedingly perfect, retaining all the delicate markings on their exterior surface; while others are twisted and contorted in a singular manner. Others again are in a collapsed state, one valve having been crushed in, as if done by great pressure. Beds of this marl have been opened in Geneseo and South Avon, where it was mistaken for gypsum, and used as such in the vicinity; and it would seem, from the results, with equal advantage to the agriculturist. One specimen from South Avon yielded thirty-six, and another sixty per cent. of carbonate of lime. In neither could I detect any sulphate."

Mr. Hayes thus continues to describe the evolution of the gas itself:—

"It is also from this slate or shale that carburetted hydrogen gas is evolved, at the numerous places denominated 'burning springs.' But a single instance has come to my knowledge of this gas issuing from any of the inferior strata. At Gasport, six miles east of Lockport, and of course below the limestone strata, gas is said to rise from the bed of the canal; from which circumstance the place doubtless takes its name. I have not examined the place in particular reference to this subject; but from the descent of the canal at Lockport, and the relative thickness of the limestone formation at that place, I have no doubt it issues from the shale immediately beneath, which at the falls is partially bituminous. I am aware that Professor Eaton has cited the burning springs in the vicinity of Canandaigua as issuing from 'beneath the saliferous rock.' Now from a long residence in that village I am quite sure that the saliferous rock no where comes in view near that place. The village itself is underlaid by limestone, which, I have good reason to believe, passes under the superincumbent shale, about half a mile south-west of the principal street. The nearest place where the gas issues is in the town of Bristol, about eight miles in the same direction. The shale is there in sight, and constitutes nearly the whole range of hills which extend from there, southerly, to the high grounds in Allegany county. Thin seams of coal have been found at no great distance from the spot where the gas issues. Large quantities of gas are also discharged ten miles south of Canandaigua, near Rushville. There it was conveyed by logs into one of the farm houses, and was used, not only for the purpose of procuring light, but for culinary purposes, and likewise to warm the apartments; no other fuel being used when I visited the place during severe winter weather. It was also used to boil down the sap of the sugar maple in the manufacture of sugar; but some accidents occurring, it was discontinued. I have traced the same formation from this place, likewise, to the high grounds in Steuben county, where one of the head branches of the Susquehanna takes its rise. At Fredonia, where gas is collected in sufficient quantity to light the whole village, it issues directly from bituminous shale; at which place the saliferous rock must be several hundred feet below the surface. The same gas at Niagara Falls on the Canandaigua shore, comes from this shale, or from the upper layers of the cherty limestone; the seams of which are there filled with a black, bituminous matter, which can be removed in scales from the thickness of a knife blade to one-fourth of an inch.

"To me these facts seem conclusive evidence that the gas originates above the saliferous sandstone. Otherwise, it should find its exit through the sandstone itself, near the shore of Lake Ontario, where the least possible resistance would be opposed to its escape. Is it not far more philosophical to conclude, that this gas is formed in these strata, where we know the elements requisite for its composition exist, than to suppose it comes from coal beds deep seated in the bowels of the earth, the bare existence of which is altogether hypothetical?"

The uses of zinc, long greatly limited by the imperfect mode of manufacturing this metal, have been greatly extended since this process has been brought to its present perfection. Professor Caswell's paper is written in answer to certain objections against the use of this metal, which had been published by Dr. Gale, of New York. The objections are—the difficulty of making the roof tight; the deterioration of the water which falls from it, and the comparatively small resistance which it offers to the progress of fire. The author observes:—

"As to the first of these objections, the brittleness of the metal and its great expansion from heat are adduced, to show that a roof cannot be made sufficiently tight. Zinc in the unwrought state is well known to be very brittle, and there may be in the market rolled or sheet zinc of a bad quality. But no one need be deceived on this point, since nothing is easier than to test its flexibility. Sheet zinc which will bear to be doubled and hammered down without any appearance of fracture in the bend, may be used as a covering for buildings, without the least fear of leakage. Such is the fact with regard to sheet zinc which I have examined from your manufactory; and such, I am assured, is the fact with regard to foreign zinc from the best manufactories. But any detailed examination of the brittleness and expansion of zinc, so far as this question is concerned, is entirely obviated by the well ascertained fact, that there is no practical difficulty in making a zinc roof perfectly tight. The numerous certificates which you have submitted to my examination, from most respectable gentlemen, who have made the experiment, place the subject beyond all reasonable doubt. A zinc roof may as easily be made tight as any other whatever.

"The second objection respects the deterioration of the water which falls from the roof. This consideration is particularly important to all those who are in the habit of using cistern water for culinary and other domestic purposes.

"It is alleged that a poisonous suboxide of zinc is dissolved in the water, which renders it unfit for cooking, and impairs its properties for washing. On this point I have consulted the ablest modern writers on chemistry, Brande, Turner, Thomson, Berzelius, and others. The oxides of zinc seem not to have been much studied. The principal one known, and perhaps the only one certainly known, is the white oxide (sometimes called the flowers of zinc), which is quite insoluble in water, and hence could not vitiate its properties. Berzelius thinks there are two others, the suboxide and the superoxide.

"The suboxide is the grey coating formed on the surface of zinc by exposure to the weather, and this is the substance which, it is said, is dissolved and mixed with the water, which falls from a zinc roof, thereby impregnating it with deleterious properties. This opinion, so far as I can learn, is unsupported by any writer on chemistry. Turner says, 'zinc undergoes little change by the action of air and moisture.' 'Aikin's Chemical Dictionary,' a work of merit and authority, says, 'the action of the air upon zinc, at the common temperature, is very slight; it acquires a very thin superficial coating of grey oxide, which adheres to the metal and prevents any further change.' The statement of Thomson is, that zinc, when exposed to the air, soon loses its lustre, but 'scarcely undergoes any other change.' The account given by Berzelius, the ablest chemist of the age, is very explicit and much to the point. He says, 'this oxide is formed on the surface of zinc which remains a long time exposed to the contact of the air It has a dark grey colour when moistened, but by drying becomes of a light grey. Ordinarily it forms a thin crust on the surface, which neither increases nor experiences any change in the air; but acquires great hardness, and resists, better than the metal itself, the mechanical and chemical action of other bodies. A piece of zinc sufficiently suboxidized at the surface, dissolves with extreme slowness in the acids, and only at the boiling temperature.'

"Such are the opinions of chemists, and particularly of Berzelius, whose unrivalled skill and accuracy in chemical analysis, have been the admiration of all cotemporary chemists."

With regard to the two latter objections, Professor Caswell considers that the quantity of zinc dissolved in water must be exceedingly small, and that as the melting point of zinc is about 700 degrees of Fah., that little danger need be apprehended from fire. We extract the following suggestions as well deserving of attention:—

"Complete protection against fire is perhaps unattainable; at least we can never be sure that we have attained it. In the progress of the arts, great improvements no doubt will be made in the mode of defence against the attacks of this destroyer. I am not aware that the following construction for a roof has ever been tried. For cheapness, tightness, durability, and resistance to fire, it seems to be well deserving the attention of builders. Let the rough boards of the roof (and the rougher the better), be covered with a thick coating of common lime mortar—then lay down the ribs, if I may so call them, for the zinc plates—then cover the whole with zinc, according to the most approved method of applying it. Such a roof would be in no danger of leakage, unless the water accumulated upon it so as to stand above the ribs, in which case no roof would be tight unless it were calked or soldered throughout. This covering, if I am rightly informed, would be nearly as as cheap as slate—quite as cheap as tin, cheaper than iron, and more than three times cheaper than copper; and would at the same time resist fire much better than either of them. A heat that would melt down the copper and iron, would, of course, melt the zinc, but would leave the mortar uninjured. The peculiar advantage of the mortar is, that it is infusible except at a very high temperature, while the closeness with which it adheres to the wood work is such as to exclude the air and thus prevent combustion. If the mortar should be kept at a red heat for some length of time, the wood beneath it would be charred, but could hardly be burnt. In case of fusion, the zinc might be replaced without injury to the mortar. I know of no construction for a roof that would be more completely fire proof than this."

With this extract we conclude our notice of Professor Silliman's ably conducted Journal, cordially wishing it that success both in America and Europe, to which it is so well entitled, as the principal periodical devoted to the advancement of science on the opposite side of the Atlantic.

EXTRACTS FROM FOREIGN SCIENTIFIC WORKS.

No. XIV.

REMARKS ON THE MINING OPERATIONS OF THE MOORS AT RIO TINTO, IN SPAIN, AND THE PRESENT PROCESS OF PROCURING COPPER BY DEPOSITION.

By M. J. Ezquerra del Bayo.

The paper of which a translation is given below, will be read with interest by many of our mining friends, and we think they will, in some cases, be able to benefit by the process here described, as there are few copper mines in which the water is not more or less impregnated with copper—in some cases, as we have found by experiment, to a considerable degree:—

The Rio Tinto mine is situated on the borders of the provinces of Seville and Estremadura, eleven leagues northward from the city of Seville. The object of the miner's labours is a mineral mass of very great extent, consisting of iron pyrites, containing copper, but only in a small proportion. The mine was worked in the time of the Romans, probably even at an earlier period, and subsequently by the Moors; when the latter were expelled, they destroyed not only the entrances to the levels, but even those of the shafts, so that for a long period the works were suspended. The mineral deposit is situated in transition clay-slate, in a direction pretty nearly from north to south, and dipping east; but the exact relation of the metalliferous lodes to the slate is not ascertained. The level in which the Moors obtained the ore is made in the hanging-wall of the rock at rather an acute angle; and, as it may not be uninteresting to know the method they pursued, I need scarcely apologise for here inserting a brief account of it.

The Moors, not being acquainted with the compass, were obliged to form a communication between the works below and the surface, by means of a number of shafts, in order to ascertain the points aboveground corresponding to that of their labours in the mine. Two levels were driven, one under the other, the upper one being used for the works, and the lower for draining the water; the latter, or bottom level, could not be used for mining operations, and was connected with the upper level by shafts. The upper shafts serving for ventilation, but principally to direct the progress of the miners, as above stated, were only driven down to the upper level; but as they were intended to answer the same purpose in regard to the lower level, a smaller shaft was driven down upon the lower level from a point underneath each of the upper shafts.

In 1725 the mine of Rio Tinto was undertaken by a Swedish company, under the direction of Messrs. Wolters and Tiquet, although not exactly on the old workings—the vicinity of which is pointed out by enormous heaps of slag and scoria; and it was only in 1780, that Mr. Sanz, a Valencian by birth (at that time managing director) succeeded in re-opening the old levels. The bottom level could not be driven upon, in consequence of the entrance being ruined, and the level itself blocked up with stalactites, formed by sulphate of copper, in a state of decomposition. This level, therefore, continued under water, and the working or upper level was used for draining.

In 1782 the mines became the property of the crown, and were placed (in 1787) under the management of Mr. Angelo, who had travelled in foreign countries, and acquired considerable experience in mining concerns and metallurgy; and who, finding that the water which drained through the old working level, contained sulphate of copper, made arrangements for extracting the copper by deposition. It is, therefore, incorrectly asserted by a French writer, that the first person who noticed the abundance of copper in these waters was an artillery officer in Napoleon's army, on its march through the district. The officer to whom allusion is made never ventured into the mines, and was as little acquainted with the patriotism of their managers as with their devoted attachment to their king and to the national cause. They led him to believe that the waters were suffered to flow away without being made any use of; but they concealed from him that they had bestowed in the remotest corners of the mine not only their goods and valuables, but even their women. To the general in command of the division they represented themselves as exceedingly well affected, but wretchedly poor, without either provisions or money. By this deception the French were induced to remain only a few hours, when they continued their march—not, however, forgetting to take with them the stock of copper which they found in the store. The next day a Spanish column entering the district found every thing in its former order.

Mr. Angelo first made use of old iron for deposition; but soon finding that this plan did not deprive the water of all its copper, he ordered bar-iron for the purpose from Biscay. Other improvements were gradually introduced, which have brought the establishment to the condition in which I found it in 1828, when I was commissioned to make a survey of the whole mine, as well as of the works and foundries aboveground. The old level, now called the deposit level, is 432 yards or *varas* in length, from the entrance to the first spring, which is nothing more than an old sink in the mine; from which the level takes a direction nearly at right angles towards the foot wall, but without entering it, and terminates at the distance of fifty yards from the former at a second sink, likewise filled with water. The whole length of the level is therefore 482 yards. The water from these two springs is conducted into a reservoir, formed in the floor of the working level, by means of two wooden launders, one foot wide and nine inches deep. The first reservoir is fifty yards from the first sink, and the water, running through a wooden launder, 140 yards in length, into a much smaller reservoir, passes off through two launders, each 110 yards long, the whole length of the trench being 540 varas, or 495 English yards. The launders are not placed horizontally, but with a fall of about 8½ feet in 100; the iron bars laid in them are three inches wide, eight to ten lines in thickness, and about two feet long, so that they can be placed in a slanting position against the stream. Every month these iron bars are cleared of the copper adhering to them, and fresh bars are placed in their stead, as may be required, in proportion to their consumption—a labour usually occupying twenty-four hours; during which time, however, some copper is lost, for want of iron bars being replaced in the water. When the launders are filled with the bars, the copper is entirely precipitated from the water.

By Mr. Angelo's observations in 1783, it appears that 48,000 lbs. of water were emitted by the two springs in an hour; my own observations in 1828, made, it is true, during the driest season, gave only 46,000 lbs. in the hour. It was, unfortunately, out of my power to make an analysis of the water, so that I could not ascertain its proportion of sulphate of copper. The annual consumption of iron is 150,000 lbs.; and the weight of copper obtained is 112,500 lbs.—being 133⅓ lbs. of iron to 100 lbs. of copper. Since my visit to the mine further improvements have been adopted, but I have not learned the particulars.

At Schmölnitz, in Upper Hungary, a much greater, that is, at least, double the quantity of deposit copper is obtained, but the process is not conducted with so much economy as at Rio Tinto. The water is here raised out of the mine with pumps, conducted into two large wooden reservoirs, and from them into a great number of small pits, lying beside and under one another, and filled with iron; the stream being caused to proceed at the slowest possible rate from one pit to another. Until very lately bar-iron was employed here as well as at Rio Tinto, at the rate of 260 lbs. to 100 of copper; but, from experiments recently made, it appears, that by using cast-iron only 167 lbs. are wanted to obtain 100 lbs. of copper. On account of the large stock of bar-iron in the store, pig iron was used only in part with it—during my stay, the proportion of iron being 180 lbs. to 100 of copper. The statement of the proportion of number of pounds agrees perfectly with the results of my experience in Schmölnitz; but I must be allowed to observe, that the official managers themselves considered the consumption of iron far too great, and occasioned by mismanagement, which, it was hoped, would soon be remedied, since it had been ascertained that 167 lbs. of pig-iron were equal in effect to 260 of bar-iron; and it was, therefore, expected, that the proportion above stated of 167 to 100 would soon be considerably lowered by using bar-iron again instead of pig-iron, as it was correctly presumed, that bar-iron must yield an incomparably greater effect than pig-iron, both in time and quantity. In other respects the Schmölnitz works appeared to me to be arranged in a masterly manner; and I am in doubt whether the rapid flow of the water impregnated with copper be preferable to its passage with the smallest possible fall.

On comparing the process of Schmölnitz with that used at Rio Tinto, we find that important advantages are derived at the former place from the introduction of pig-iron, yet without by any means equalling the economy of consumption observable at Rio Tinto. I am inclined to think that the latter place has the advantage, since the water impregnated with the copper is impelled with a degree of rapidity against the iron bars placed in a slanting direction. The phenomena of this process arises, it is true, from the greater tendency of the iron than of the copper to combine with the acid; but yet the process is expedited and assisted by mechanical means in the same manner as many solutions are brought into a state of crystallization.—*Karsten's Archiv., vol. 4, p. 411.*

Colossal Steamers.—An immense steamer, upwards of 200 feet long, was lately launched at Bristol, for plying between England and America; but the one now building at Curling, Young, and Co.'s, Limehouse, for the American Steam Navigation Company, surpasses any thing of the kind hitherto made. She is to be named after our Queen, the Victoria—will cost from 80,000*l.* to 100,000*l.*; has about 150 men now employed daily on her, and is expected to be finished in about November next. The extreme length is about 253 feet, but she is 237 feet between the perpendiculars, 40½ feet beam between the paddle-boxes, and 27 feet 1 inch deep, from the floor to the under side of the spar deck. The engines are two of 250-horse power each, with 6 feet 4 inch cylinders, and 7 feet stroke. They are to be fitted with Hall's patent condensers, in addition to the common ones. She displaces, at 16 feet deep, 2740 tons of water; her computed tonnage is 1800 tons. At the water line every additional inch displaces 18½ tons. The average speed is expected to be 200 nautical miles per day, and consumption of coal 30 tons. The best Welch coal is to be used. It is calculated she will make the outward voyage to New York in eighteen days, and the homeward in twelve, consuming 540 tons of coal out, and 360 home. Expectation is on the tiptoe for the first voyage of this gigantic steamer, alongside of which other steamers look like little fishing-boats.—*Railway Magazine.*

Silk-worms.—The cultivation of the mulberry-tree, and the raising of silk-worms, has been adopted in Switzerland with great success. At Basle August, in particular, this new source of wealth has been astonishingly productive.

ROCK SALT MINES OF HALLEIN.

In our last Supplement we gave an account of a visit to one of the rock salt mines of Cheshire, from the able pen of Sir George Head, and the following extract from Dr. Granville's recent work on the "Spas of Germany," contains an extremely graphic sketch of the remarkable mines of rock salt at Hallein. In a practical point of view, we would direct the attention of our mining friends to the preservation of the mine timber, arising from accidental contact with the salt, for (taking the hint from this circumstance), from being previously soaked in the brine. It appears from the Doctor's statement, that the *bichloride of sodium* is likely to be as efficacious for this purpose as the *bichloride of mercury*, employed in Mr. Kyan's process; and we need not say that it is infinitely cheaper, and more readily attainable. Perhaps some of our readers will try the experiment.

"I reached the celebrated salt mines in the neighbourhood of the small town of Hallein, after having ascended the steep and winding road of the Durrenberg. * * Armed with the necessary order from the inspector of the mines, I knocked for admittance at the gate of the *Manipulation-Hof*, and was received into a large square room, hung with pictures of the ancient and most renowned miners, some of whose descendants stood before me in reality, with their stern countenances—thick-set, square-shouldered, robust-looking, and clad in the trappings of their order. * *

"A register of the visiters was presented to me, and by a mere token of the extended finger, *sans mot dire*, I received directions to inscribe my name in it. While doing this, the names of Dr. Child, of M. Burmester, and of Mr. Busbury, (who took the trouble to designate himself, to this sturdy race, as 'of Angher Castle in Ireland')—and lastly, of the fair Mrs. Trollope, caught my attention, as having visited the mines a few days before. But I was soon recalled from my readings, by the brusque handling of one of the miners, who set about decking me in the upper garment of their calling, while a second supplied me with the nether one, and a third buckled around my waist the broad belt, within which he fixed a stout right-hand glove of leather, as if to prepare me for a share in their laborious work. * *

"As I surveyed myself, on quitting the presence of the taciturn chief, to follow the guide he had assigned me—I could not resist tempting him to break his silence by asking whether the fair lady whose name was last inscribed on the register, and who, I explained to him, was a renowned English traveller, had also submitted to wear the garb of the miner, with the characteristic nether part of it? 'Even so,' was the reply.

"Litner, a robust-looking man, full of intelligence, and, as I afterwards found, of information also, aged fifty-four years, twenty-four of which he had passed in the dark recesses of the Durrenberg, with the rank of an *Arbeitführer*,) was the conductor whom I followed to the low arched entrance (*Einfahrt*) of the mine, over which was the inscription, 'Ober Steinberg, 1450.' This is the name given to the fifth of the nine stages or stories into which the internal mine is divided, reckoning from the highest, or the one nearest the summit of the mountain. Having entered the dark passage of *Freudenberg*, lighted by a short candle carried by the conductor and by myself, we walked through it, in a straight line, for a distance of nearly two thousand feet, the first four hundred of which presented a wall on each side of white *Untersberger* marble. This, like all the other passages or galleries through which I passed afterwards, called *Haupt stollen*, runs horizontally into the mountain, and meets the shafts. These galleries are generally two feet wide near the floor, with two parallel rails, on which run a kind of low-wheeled waggons, conveying the ore and mineral salt from one part of the mine to another. The rails admit also of a species of car, placed on four low wheels, in which the visiters who prefer that mode of conveyance to walking, are drawn by one or more miners with astonishing rapidity. The walls of these galleries approach each other nearer at the ceiling than at the floor, and are supported either by piles of wood or by masonry. As it was discovered that, where the wood was most exposed to the action of the salt-earth, it became harder and harder, and was scarcely ever after liable to decay, all those piles which, when fixed, are not necessarily in contact with the salt parts of the mountain, are previously soaked in brine. Now here is a hint for a rival company to Kyan's monopoly, which I am convinced offers no greater security against the decay of wood than strong brine would. It will be found on trial that the *bichloride of sodium* in this respect is as efficacious as the *bichloride of mercury* employed by Kyan.

"How ventilation is carried on in these passages, it is not easy to discover. The entrance of the external air is carefully prevented, by several doors called weather-doors; and so effectually is this managed, that in no part of the mine, (which extends nearly four miles, taking all the galleries, shafts, and recesses together,) whether I was walking, or riding on the car, did the flame of my candle flicker in the smallest degree. That there is, at times, a want of air, is evident from the fact, that an arrangement exists in some parts for supplying it to the miners, when at work, by means of bellows. * *

"We descended about two hundred steps cut in the rock, at the termination of this first passage, in order to reach another and lower portion of it, which brought us to the brink of what appeared to me a bottomless pit. The 'darkness visible' of the place at first hardly permitted a more careful survey; but when the eye became, at last, accustomed to the dingy atmosphere, I could perceive before me a narrow inclined plane, at an angle of forty degrees, the *terminus* of which was left entirely to imagination to divine. On the inclined plane, and in the direction of its axis, two parallel lines, one foot apart, formed of smooth, polished, wooden cylinders, (being portions of the trunks of fir trees,) six inches in diameter, placed contiguous to one another, are laid down, and secured by short cross pieces. A tightly-drawn rope runs close to and parallel with the cylinder on the right.

"Litner here looked round for the first time since we had entered these singular regions; and pulling from my girdle the glove, bid me put it on my right hand, and follow his example. He grinned at the same time a smile of encouragement, probably because he saw on my pale face the momentary feeling of my heart. Litner next stretched himself upon the inclined plane, keeping his head somewhat erect, and touching with his body both wooden cylinders, across which his legs were thrown slanting. He held his light with the left, while within the palm of the right-hand he grasped the tight rope, keeping the thumb free and aloof from it. * *

"I stooped on the brink of the dark abyss, behind my guide, seated myself on the cylinders, and placed my feet against Litner's broad shoulders, while, with my hand passed under the rope, I strove to gain some security by holding it tight. The moment Litner felt the weight of my person inclining against him, he suffered himself to slide downwards, followed by me; and down, down we glided at a giddy pace, my breathing held in suspense, so that the dead silence of the dark cavern into which we were thus plunging resounded only with the wind-like hissing of the rope, as it passed rapidly over the rough glove on our hands, and with the distant murmuring and splashing of unseen and falling water. In one minute and a half, we were again on our feet at the end of this shaft, called Freudenberge Rolle, three hundred and fifty feet deep.

"We had now reached the fourth story of the mine, called the *Unter-steinberg*, where a passage, six hundred and fifty feet in length, leads to a second shaft, very appropriately called *Jacob's Ladder*, one hundred and eighty-nine feet deep, and placed at forty-six degrees of inclination. On the right and left of this passage, the miners were seen, busy at their toilsome task, in parties of four, working with the regularity of soldiers. It is in the passage at the termination of this steep descent, that we find the most productive salt strata. * *

"Two other shafts at an angle of forty-three degrees, the *Königs Rolle*, and the *Kunhauser Rolle*, are descended in the like manner, in order to view the *Rupert's Berg*, or the lowest stage but one of the mine. Here the visiter is startled at perceiving place like a room, cut out of the rock, called the 'Comandirende's Salzaber,' containing the Austrian arms, and the monument of St. Rupert. In a niche scooped out of the rock, specimens of the different strata which occur in the mine are exhibited, together with some Roman antiquities found here in 1825, the date of which has been determined by the royal warder of the Salines, who is a great antiquarian, to be one hundred and eighty years before Christ.

"Hitherto fear had given way to admiration, and fatigue to the pleasure of witnessing these stupendous works of nature and man. But the greatest surprise was yet to come, and great it was indeed, when upon the throwing open of a door which seemed to bar the avenue we were then pursuing, I suddenly emerged from comparative darkness and a narrow pass, into a wide expanse, lighted up, all round by hundreds of tapers. These, being reflected from the surface of a dark and still lake of liquid brine, which spreads widely below them, and from the low and extended ceiling above, which was sparkling with the deliquescent moisture of the salt rock, seemed at first to be of ten times their real number. The sudden appearance, too, of several of the miners in their bizarre costume, whispering in low murmurs to each other; some on the brink of this dismal lake, looking on; while others were pushing a flat bark on its liquid surface to the spot on which I stood, inviting me at the same time, and by mute signs only, to embark on it, added to my first surprise the more intense feeling of interest. At the first glance, one might have fancied himself in a very large square at night surrounded by an illuminated town; and the veins of salt rock, which were of red, green, yellow, white, and blue tints, mixed with crystals of selenite, sparkled and shone like precious stones. * *

"The only way out of this dreary abode, however, was by crossing the lake. This Litner made me understand, when he found that I hesitated to place my foot on the bark. He then set me the example:

Lo duca mio discese nella barca,
E poi mi fec' cattar appresso lui.

And the frail bark conveyed us across, where, being landed, we proceeded to the almost perpendicular *Rolle*, two hundred and fifty feet deep, which led to the lowest division of the mine, called the Wolfdietrick's Berg. This region is one thousand three hundred and twenty feet deep, in a perpendicular line, from the spot on which stands the little church I had visited, near the entrance into the mines.

"The length of the gallery of this stage of the mine, the lowest of all, is eight thousand and forty feet, one-third of which is cut through grey limestone. It leads to the gate of egress, (*Ausfahrt*,) towards which I thought we should now walk, without any further interruption. Our progress, however, was suddenly checked, when at about seven thousand feet from the *Ultima Thule*, by a door which barred the passage. This, at the clap of Litner's hands, was mysteriously opened, when two gigantic miners appeared, one placed at each end of a car or bench, such as I have already described, called a *Burgwurl*, suspended by ropes over a sledge, the grooves of which were locked over the rails on the floor of the gallery. On this vehicle Litner and myself placed ourselves astride one behind the other; when, at a signal, the door behind closed upon us with a deafening noise and prolonged reverberations; and away went the machine, drawn by the miner in front and impelled by the one behind, with such rapidity, that we accomplished the whole distance in ten minutes.

"Our candles just before this time had begun to verge fast to their last and expiring scintillæ, and finally went out—leaving us in total darkness, scudding at a fearful rate through a straight and narrow passage which echoed the tramping of the two running miners. This *coup de théâtre* was purposely brought about by calculating the duration of the candles, in order that we might enjoy another and a concluding sight. When distant about two thousand five hundred feet from the egress gate, Litner bid the conductor to stop, and called to me to look over his shoulders and straight forward. I did so, and at a distance, of the length of which I could form no idea, I perceived a minute twinkling star in the middle of the passage. I kept my eyes steadily upon it; the sledge once more advanced with increased velocity, and the star also increased in size; when about twelve hundred feet distant it looked like the rising moon, as round and as bright; until at length it changed into the full glare of the brightest sun. The passage, which is just wide enough to admit of the species of car I have described, felt cold and damp from the deliquescent salt by which we were encompassed, as well as from the brisk fanning of the air through which we darted with so much rapidity. When, at length, our car, by a last effort, was ejected some distance out of the bowels of the mountain into the external atmosphere, the sudden impression of light and warmth was quite delightful.

"I found, in a small house at the *Ausfahrt*, the clothes I had left at the entrance on the other side of the mountain, and there deposited the miner's garb—giving a gratification of three florins and a half to the conductor, for himself and his brethren, and receiving from him in return a small box containing specimens of all the varieties of coloured salt rock."

NEW YORK STATE RAILWAYS.

The incorporated railroad companies in the state of New York, in 1836, were fifty; their capital varying from fifteen thousand to ten million dollars. When I first crossed the Alleghanies, in 1834, I caught a glimpse of the stupendous Portgage Railroad, running between the two canals which reach the opposite bases of the mountains. The stage in which I travelled was on one side of a deep ravine bristling with pines; while on the other side was the lofty embankment, such a wall as I had never imagined could be built, on the summit of which ran the railroad, its line traceable for some miles, with frequent stations and trains of baggage cars. One track of this road had not long been opened, and the work was a splendid novelty. I had afterwards the pleasure of travelling on it from end to end.

This road is upwards of thirty-six miles in length, and at one point reaches an elevation of 2,491 feet above the sea. It consists of eleven levels and ten inclined planes. About three hundred feet of the road, at the head and foot of each plane, is made exactly level. The embankments were made twenty-five feet wide at the top, and the bed of the road in excavations is twenty-five feet, with wide side ditches. Much care in drainage was necessary, as the road passes chiefly along the steep slopes of hills, of clayey soils, and over innumerable small streams. Sixty-eight culverts of masonry pass under the road, and eighty-five drains. There are four viaducts of hammer-dressed sandstone to carry the line over streams. The most splendid of these is over the Conemaugh, eight miles from Johnstown. It has a semicircular arch of eighty feet span; the top of whose masonry is seventy feet above the water. There is a tunnel through a spur of the Alleghany, nine hundred and one feet long, by twenty feet wide, and nineteen high. The foundations of this road are partly stone and partly wood. Each station has two steam-engines; one being used at a time, and the other provided to prevent delay in case of accident. Four cars, each loaded with 7,000lbs. can be drawn up, and four such let down at a time; and from six to ten such trips can be accomplished in an hour. A safety car is attached to the train, both in ascending and descending; and though not an absolute safeguard, it much increases the security. This little machine, when pressed upon from behind, grounds its point, and materially checks the velocity of the otherwise flying train. The iron rails, and some other of the metal portions of the work, were imported from Great Britain.

The cost of constructing this railroad at the contract prices was 1,634,357 dollars; but this does not include office expenses, or engineering, or accidental extra allowances to contractors. During the first year of the two tracks being opened, fifty thousand tons of freight, and twenty thousand passengers, passed over the road.

Five years before, this line of passage was an untrodden wilderness. The act authorising the commencement of the work passed the Pennsylvania Legislature on the 21st of March, 1831. On the 12th of the next month, the tents of the first working party were pitched at the head of the mountain branch of the Conemaugh. The party consisted of two engineers, a surveyor, twelve assistants and axemen, and a cook. A track, one hundred and twenty feet wide, overgrown with heavy spruce and hemlock timber, had to be cleared, for a distance of thirty miles. The amount of labour was increased as the work proceeded; and, at one time, as many as two thousand men were employed upon the road. On the 26th of November, 1833, the first car traversed the whole length on the single track that was finished. The canals were then closed for the season; but, during the next March the road was opened for a public highway. In another year the enterprise was completed: and in May 1835, the State furnished the whole motive power. The stupendous work was then in full operation.—*Miss Martineau's America.*

ANCIENT METALLURGY.

We extract the following interesting notice of ancient metallurgy, from an able article on the recently discovered Egyptian antiquities of Luxor and Karnac, which has appeared in the *Athenæum*:—"We cannot conclude this portion of our subject without some reference to the works in metal, which rank next in importance to weaving. It would appear that the Egyptians were ignorant of the use of iron, for all the implements not formed of gold and silver, are painted green, and must manifestly have been made of brass. We need not remind our classical readers, that all the weapons mentioned by Homer are said to have been formed of this metal. Casting must have been carried to a high degree of perfection, for most, if not all, of the war chariots are brazen; a circumstance proved not only by their green colour, but by the lightness and neatness of their wheels, and their beautiful ornaments, too elaborate to have been carved. Swords, quivers, knives, axes, and adzes are all formed from the same material, and even some bows appear to have been formed of this metal. As there were no mines in Egypt, it seems probable that the great quantity of metal required in the arts was obtained from the interior of Africa. Copper in hardness, bears the proportion to iron of about eight to nine, and was therefore not very much inferior to it before the art of forming the latter into steel was discovered. The monuments clearly show us that iron was either unknown or unused in the flourishing days of the Pharaohs, and this circumstance tends strongly to demonstrate the antiquity of the Pentateuch, and consequently its authenticity as a contemporary document, when we find that invariably the metals described as employed for use or ornament, are those only which appear on the ancient monuments of Egypt. Thus Bezabel is said to have been instructed 'to devise cunning works, to work in gold, in silver, and in brass.' (Exodus, xxxi. 4). It may be necessary to add, that in Hebrew the same word signifies both brass and copper; our translators invariably use the former, even when the native copper is mentioned. The account given of the structure of the tabernacle proves that metallurgy must have been well understood in the days of Moses, and, from the description of the golden calf, we may infer that the casting of idols and statues was no uncommon practice. Gilding was certainly understood by the Egyptians, for we find traces of it on the mummies and the mummy cases. It would be too long a digression to examine whether the 'overlaying the boards of the tabernacle with gold,' (Exodus, xxxvi. 34,) refers to gilding or a covering of thin plates; but, in support of the former view, we may notice that the weight of the plates would have rendered the tabernacle very difficult of transport, and a positive incumbrance to the Israelites in their journeying through the desert; the amount of gold, too, collected by Moses, would not have supplied sufficient material for plates, however thin, to cover the entire edifice; and, finally, the word here rendered 'overlaying' is the same used to describe the decorating of the carved work in Solomon's temple, which must have been gilding, as plates, however thin, would have concealed the tracery and foliage described to have been wrought with so much artistic skill. Metal mirrors were in common use among the ancient Egyptians; they occasionally appear on the monuments, and are mentioned by Moses in the account of the brazen layer. 'He made the laver of brass, and the foot of it of brass, of the looking-glasses (metal mirrors) of the women assembling.' (Exodus, xxxviii. 8). The Egyptian women of rank appear to have used mirrors of burnished silver. Bells, chains, ear-rings, and other metallic ornaments, are not only depicted on the monuments, but found in the tombs. Having recently described Giovanni d'Athanasi's collection of Egyptian Antiquities, in which there were many beautiful specimens of such trinkets, we do not think it necessary to dwell further on the subject."

DERBYSHIRE MINERALS.

This mineral (martial pyrites), so obnoxious to the Derbyshire miners, is a sulphuret of iron, and it is one of the commonest ores of this generally diffused metal. It is found in nearly all the various strata of the globe, in rocks of granite, gneiss, marble, and slate—in beds of mica-slate and coal—sometimes it occurs in masses—sometimes it is disseminated in veins, and frequently it is found in shining and splendid cubic crystals. In hardness it exceeds all metallic minerals: the point of the best tempered knife makes no impression upon it—hence it may be easily distinguished from copper pyrites, to which it nearly approximates in lustre and appearance; when struck with steel it gives out sparks, and under the blow pipe it emits a sulphureous odour. Its component parts are, sulphur 52—iron 48.

The principal use to which this mineral is applied, is the making of copperas and green vitriol, which is a decomposition of martial pyrites; and, latterly, it has been made to produce sulphuric acid. In the year 1818, a patent was taken out by some gentlemen in the vicinity of London, for making this acid from pyrites, in a way not previously discovered; and they have now a large establishment for the purpose at Bromley, in Kent.

Another material found in this mine in conjunction with galena, limestone, and calcareous spar, is sulphate of barytes, provincially called cawk. This substance is known by different designations—it is the *terra ponderosa* of Bergham—by others, who have written on the subject, it has been denominated vitriolated heavy earth—ponderous spar—prismatic spar; and by more scientific mineralogists, caroselenite. In the mines of Derbyshire, it is generally associated with calcareous spar and lead ore; but in the neighbourhood of Matlock and Bonsall, it is found amongst the hills unconnected with metals.

I have occasionally met with this minera' of a clear pure white; sometimes of an opaque glassy appearance, similar to what is called French opal, and imperfectly crystallized; but the most beautiful variety that occurs in Derbyshire, is at Moot-hall mine. It is of a delicate rose colour, and, when freshly broken, it exhibits a bright foliated fracture. I, however, suspect that such specimens are extremely rare. The common appearance of this mineral, when in a massive state, is a dull, earthy white, like dingy-coloured chalk; and this appears generally to be the case when it is found intimately connected with galena: but I have met with it of a very delicate and beautiful hue from the mines in the vicinity of Wirksworth. Its constituent parts are, barytes 67, sulphuric acid 33.

This very abundant material is used for many valuable purposes; but it has never yet been found, except in combination with other matter. "Its affinity," says Parkes, in his Chemical Essays, "to the carbonic and other acids is such, that it cannot exist in a pure state." In the neighbourhood of Cromford, along Bonsal-Dale, and amongst the neighbouring hills, this substance is collected in large quantities, and manufactured into a fine white colour, well-known amongst house painters by the assumed name of "Hume's permanent white."

A curious variety of sulphate of barytes, and totally unlike any that had previously been met with, was recently discovered in the neighbourhood of Youlgreave. The persons who found this new material imagined, from its great weight, that it was a metallic ore. A portion of it was, therefore, sent to Matlock, that its quality and value might be ascertained; when, although proved not to be metallic, it was soon converted to a profitable purpose. The formation of this substance is decidedly stalactical. The larger shapeless masses that were discovered were all distinguished by a rough exterior of a dirty ea thy-brown colour; but when found in the form of stalactites, they were almost invariably encrusted with crystals common to this mineral, all imperfectly developed and none transparent. When broken across, the whole of these specimens of barytes exhibited a series of concentric layers, evidently produced by successive depositions; an appearance which sufficiently denot d that other shades of colour lurked beneath the surface. The coating was removed; a fine warm-toned brown hue appeared; and working further, lighter tints were observed; until at length, when the piece was polished, it had altogether the appearance of richly variegated tortoise-shell, without the transparency. This beautiful variety of barytes soon came into great request, and every fragment that could be found was worked up for sale. Small specimens were sold at from 5s. to 7s. each, and some larger ones for as many pounds. One piece, about twenty-four inches by eighteen, was disposed of by Mr. P. Smedley, for ten guineas, for a museum abroad. The stock of this rare and singular mineral is now nearly exhausted.—*Derbyshire Tourists' Guide.*

THE EARTH.—Our knowledge of the substance of the earth is confined to the mere skin, as it were, of the mighty mass. Take a globe of two feet diameter, and place upon it a sheet of thin writing paper. The thickness of the paper in proportion to that of the whole globe is greater than the thickness of that portion of the earth which we are at all acquainted with, in proportion to the semi-diameter of the whole earth.

EFFECT OF PRUSSIC ACID UPON A RABBIT.—Dr. Robinson lately delivered the third of a series of dissertations on poisons, before the faculty at the Maidstone Infirmary. The subject of the evening was principally corrosive sublimate, on the mode of detecting which the learned lecturer imparted some most valuable hints. At the conclusion of the dissertation the effect of prussic acid was tried upon a rabbit. Three drops were administered from a glass (the surface of which most probably abstracted half of the quantity), and the animal immediately exhibited the usual symptoms—increased action of the lungs, dilation of the pupils, and the peculiar shrill cry which in such cases is generally indicative of immediately approaching dissolution. In order to give it a chance of recovery, however, a few drops of ammonia were administered, without apparent benefit. A constant stream of cold water was then poured upon the base of the skull and along the spine, when the animal very shortly exhibited symptoms of resuscitation. It was then wrapped in warm flannel. In a quarter of an hour it was sufficiently recovered to walk. Dr. Robinson had in a former lecture mentioned that this mode of treatment had been discovered by accident. A cat which had annoyed the apprentices of a chemist, was poisoned by them with prussic acid, and thrown by for dead. By mere accident, however, it fell under a stream of water, which was pouring from a pump, the effect of which was its gradual resuscitation. Benefitting by this hint, the same means have been since successfully applied to more than one human subject who had taken prussic acid. No instance, however, had come within Dr. Robinson's knowledge where an animal had been restored after the symptoms which this rabbit exhibited; and the singularity of the case struck the faculty as being one, a knowledge of which it was desirable should be promulgated. The rabbit is now in full health and vigour.

THE PUMPKIN.—Mr. L. Hoffman, of Vienna, has obtained an exclusive patent extending to the whole of Austria, for the manufacture of sugar from the pumpkin.

THE LONDON COMMERCIAL MAN.—Whoever observes the merchant in his counting-house, the professional man engaged in his daily avocations, or the tradesman at his business, will readily come into the opinion that, in London at least, this class of persons stands highest in health and vigour. The regularity, punctuality, and activity, commercial men in London exhibit in transacting their business, their being always at their post when called on, the facility with which grand, petit, and coroners' juries are assembled, the full attendance of members at meetings of various societies and companies (particularly if a dinner crowns the business of the day), all go to establish the fact of the middling classes in London being in a good condition, exceeding that in which either superiors or inferiors are found.—*Dr. Hogg's London as it Is.*

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The Mining Journal

AND COMMERCIAL GAZETTE.

SUPPLEMENT---XXII.

DESCRIPTIVE NOTICE OF QUICKSILVER MINES IN RHENISH BAVARIA; AND THE GEOLOGICAL STRUCTURE OF THE SURROUNDING COUNTRY.*

BY FREDERICK BURR.

Of those metals which are largely applied to useful purposes by mankind, there is, perhaps, no other which has been so sparingly distributed by Nature, as quicksilver. Both from this circumstance, and from the peculiarities which characterise the deposits of this metal, the following brief sketch of one of its localities may be acceptable to the reader, although not pretending to the accuracy and minuteness of detail which might have been obtained by a more lengthened and careful examination of the district.

Before entering on this description, perhaps a slight glance at the situations where quicksilver has been principally found, and the circumstances which regulate the present supply of this metal, may not be misplaced, as these particulars form, at this moment, a subject of considerable interest, especially in reference to the foreign mines worked by English companies, for which a large consumption of this metal is indispensable in the amalgamation of the silver ores.

The continent of Europe, so rich in almost every species of mineral produce, contains also large stores of quicksilver, but limited to a few favoured spots.† The most productive mines of this metal in the world, are those situated in the vicinity of Almaden, in Spain; from these quicksilver is largely exported, both to this and other countries, so that they may be considered as the grand reservoir from which the rest of the world is principally supplied. Notwithstanding the immense quantity of quicksilver which, under favourable circumstances, these mines are capable of producing, it is hardly necessary to observe on the evils which arise from a large portion both of Europe and America, being chiefly dependent on them for a supply of this metal. Not only has the price, for sometime past, been artificially and exorbitantly raised by individual monopoly, but the present disturbed state of the Peninsula, and the gloomy aspect of political affairs in that country, threaten, for a time at least, to suspend the effectual working of the mines, and thus to produce even more serious results than those which have hitherto been felt.

Some parts of the Austrian dominions, and more especially the vicinity of Idria, in Carniola, are celebrated for their mines of quicksilver, but the produce of this empire, although considerable, is far inferior to that of the Spanish mines, and the greater part of it is retained for home consumption, being used for the amalgamation of the gold and silver ores, which are found in greater abundance in Austria than in any other country in Europe.‡ From this circumstance, there appears no reason to believe that the export of quicksilver from these mines will ever be much larger than it is at present.

Passing over many of the less productive localities of this metal, we may notice the celebrated mines of Guancavelica, in Peru, which have produced an enormous quantity of quicksilver, although, even when most productive, by no means sufficient for the extraction of the precious metals, obtained in such vast quantity from the mines of America, and so intimately and minutely disseminated throughout an enormous mass of veinstone, from which it is only by the agency of this metal that they can be extracted. For the last forty years, however, the mines of Guancavelica have greatly declined in produce, and the diminished quantity of this metal furnished by Peru, has been principally obtained from numerous small workings opened in their vicinity, and greatly inferior in richness.

Although the supply of quicksilver is at the present time chiefly derived from the sources I have mentioned, and this metal is doubtless confined by Nature to a very few localities, it is proper to notice that there are other situations where it is known to occur, although some of them have hitherto been but little explored. Extensive, but at present almost neglected mines of this metal, have long been worked in that part of the Bavarian dominions situated westward of the Rhine, and forming the ancient territory called the Palatinate. It is to the description of some of these, that the present paper will be chiefly devoted. The ores of mercury are known to occur in some parts of Sweden, and also in Siberia, but I am not aware that mines of this metal have been opened in either of these countries. This metal is understood to exist, and even to be worked to some extent, in China; but from the peculiar and exclusive character of that singular people, little beyond the mere fact seems to be ascertained. Quicksilver is also known to exist in some parts bf Mexico, where it has even been worked to a small extent; but these deposits have been in great measure neglected, in the same manner as those of many other minerals, a circumstance chiefly occasioned by the exclusive but mistaken search for the precious metals.

This last fact is one of considerable importance, and deserving of notice; for, although but little beyond the fact of quicksilver existing in Mexico appears to be known, we have no reason to believe but what that metal may be as abundant there, as we know to be the case with most others. It has even been stated by Humboldt, as by no means improbable, that Mexico and Peru might hereafter export quicksilver to Europe, instead of receiving it from thence; and it will be apparent that other causes than poverty may have prevented these deposits of quicksilver from being effectually explored, when we consider both the past and present circumstances of the country in which they are situated. While Mexico was under the control of Spain, it was evidently the policy of the latter to render her colony dependent on the mother country for this indispensable necessary in the working of her silver mines, the chief source of her wealth, and we may therefore conclude, that, under the Spanish dominion the search for quicksilver would be discouraged, while the decay of the mines following the revolution, and the unsettled state of the country after that period, were such as to prevent the establishment of any new branch of mining industry.

During the period that British capital has been employed in the mines of Mexico, circumstances have scarcely been more favourable than before, to the experiment of obtaining quicksilver in that country. In most cases the exertions of English companies have been attended with but little success, and the enormous sums expended in re-opening old and abandoned mines, have exhausted both the capital and enterprise which might otherwise have been more successfully employed on new undertakings. In the almost entire absence of positive information on the subject, we may therefore reasonably conclude, that the deposits of quicksilver known to exist in Mexico, are at the present time at least worthy of examination by competent persons, and, should the result of this examination prove favourable, a moderate outlay in making trial of some of the most promising, might be expected to lead to results successful in themselves, and highly beneficial to existing British interests.

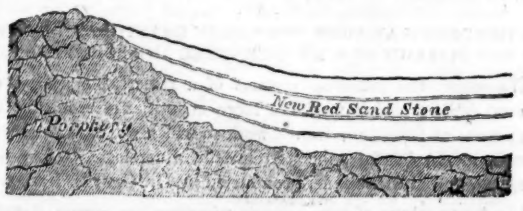
Having now briefly called attention to circumstances connected with the natural deposition of quicksilver, respecting which at the present time, it appears desirable that correct information should be extensively diffused, I next proceed to the more immediate object of this paper, or a description of some of the quicksilver mines of Rhenish Bavaria; explaining the nature of these deposits, the mode of working them, and also the geological structure and physical aspect of the tract of country in which they are situated. In my examination of this district, I regret that a longer space of time could not have been devoted; the information I was able to obtain will, however, give a tolerably correct general view of the most remarkable circumstances which characterise it.

The mines in question are situated in the mountainous country to the south of Kreuznach, a town on the southern frontiers of the Prussian territory, and lie chiefly between that place and Wolfstein. This elevated range forms indeed the northern prolongation of the well-known primary chain of the Vosges; it is partly known, I believe, by the name of the Wasgau mountains, and rises to its greatest altitude in the porphyritic summit of the Donners Berg, called also by the French Mont Tonnerre. The mines are entirely within the Bavarian dominions, and in the immediate vicinity of the village of Bingart, and of Nieder Moschel, Ober Moschel, and Alzens. They are stated to have been worked for about four or five centuries, and both the excavations below, and the immense piles of attle on the surface, prove that some have been wrought to a considerable extent, and in all probability have yielded large returns. The working has indeed never been given up for any length of time, but this part of Germany having been devastated by the French revolutionary army, in their early campaigns, the mines were for a time suspended, and operations have never since been effectually resumed. Up to this period their produce appears to have been considerable, as they were then reported, by a commission of French engineers, to produce 67,000 lbs. of quicksilver per annum, and should a spirited and efficient system of working be in future adopted, I have little doubt that large returns may again be obtained.

The geological structure of the tract in which these mines are situated, cannot be clearly understood, without taking a comprehensive view of the surrounding country, so as to determine the general relations of the various rocks occurring there. The primary chain of the Vosges, which bounds the valley of the Rhine to the westward, between Colmar and Mannheim (the eastern boundary being formed by the primary range of the Schwarzwald), is well known for its metalliferous produce, consisting of lead, silver, and copper; the vicinity of St. Marie aux Mines, in this district, having produced some of the most remarkable masses of native silver ever found in Europe. The primary rocks of this chain are encircled by secondary formations, chiefly the sandstone, called *gres des Vosges*, and these, with occasional protrusions of primary and trappean rocks, form the continuation of this range to the northward, into the district I now propose to describe. The secondary formations above noticed, extend as far north as the vicinity of Bingen and Mayence, where they abut against the slate rocks forming the primary ranges of Hündsruck and Taunus, well-known for the magnificent scenery which the narrow valley of the Rhine affords in its passage between them, in the neighbourhood of Bucharach, St. Goar, and Ober Wesel.

These slate rocks extend to some distance south of Bingen, and near that place they present a remarkable gorge, through which the river Nahe flows, immediately before its confluence with the Rhine, which here makes an abrupt deviation from an east and west to a north and south direction. In this gorge, a mile or two south of Bingen, I observed a large protruding channel of greenstone, traversing the slate in an east and west direction, and rising above the surface in a long narrow ridge, which had evidently resisted the denudation which had worn away the softer strata adjacent to it, and probably opened the singular and narrow ravine through which the Nahe now flows.

A little further southward the slate rocks disappear, being overlaid by a deep red-coloured sandstone, very similar to the new red sandstone of this country, and forming, I presume, the *gres des Vosges*, of continental geologists. This sandstone spreads over a large tract of country, extending for some miles north and south of Kreuznach, constituting, by its flat or gently undulating surface, a remarkable contrast to the bold and striking scenery of the slate rocks on which it rests, and of the trappean rocks, which in various places rise abruptly through it. The stratification of this sandstone is either horizontal or slightly inclined; the beds are usually thin and regular, the colour being, as before noticed, a very decided red. On the banks of the Nahe, a mile or two south of Kreuznach, I observed a mass of claystone porphyry rising through the sandstone, and tilting the beds in manner shown in the annexed sketch—thus



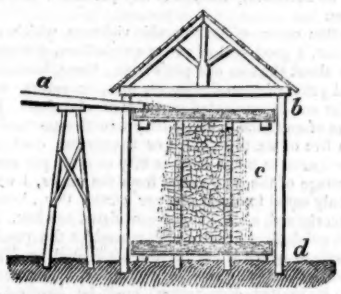
proving, that in some cases the pyrogenous rocks of this district are of later origin than the sandstone, or have undergone elevatory movements since its deposition, although the reverse appears to be usually the case. It seems, indeed, that whenever this sandstone rises into hills, their elevation is owing to the immediate proximity of pyrogenous rocks, which, from their frequent appearance at the surface, especially in the neighbourhood of Kreuznach, may be presumed to exist at no great depth throughout the greater part of this district. Some beds of the sandstone appeared to be of a marly nature, but I recognised no decided equivalent to our own red marl; it appeared rather to resemble the new red sandstone of Lancashire and Cheshire, where the sandy beds constitute the great mass of this formation. In many places a diluvial covering is spread over the sandstone, consisting chiefly of its own detritus, with quartzose, and porphyritic pebbles intermixed.

A few miles to the south of Kreuznach, there are several very extensive salt-works, where, as in Worcestershire and Cheshire, the salt is made by evaporating brine, but both the process and the material operated upon, are very different from our own, as will be seen from the following description:—One of the brine-pits which I examined, was about twenty-five feet deep, having a small lift of pumps and a ladder fixed in it, reaching to the bottom. The pit was of rather a large size, and the sides entirely without support, so that the strata penetrated, could easily be examined. I found about ten feet at the top to consist of sand, with large pebbles, and below this, reddish coloured sandstone the remaining depth. The brine rose about four feet, being sufficiently copious to supply a pump, six or seven inches in diameter, working rather slowly. Being curious to ascertain the strength of the brine, I went down the pit, and was much surprised to find it so weak that in this country it would be considered worthless. I am not aware what is the actual proportion of salt contained in this brine, but as it appeared hardly equal in saltness to sea-water, should suppose it cannot exceed two or three per cent.

The presence of brine, however weak, seeming to afford indubitable evidence of the existence of rock-salt in depth, it appeared surprising, that instead of taking this water, so slightly impregnated with salt, almost from the surface, the pits should not have been sunk to a greater depth in quest of the beds of rock-salt, which might be presumed to exist below. I have since, however, become acquainted with the very remarkable fact, that it has been proved by boring, that the salt springs of Kreuznach do not, as in this country, and indeed, most others, rise from the red sandstone, but from the porphyritic rocks which lie beneath it, so that little benefit could be expected from trials at a greater depth.

After thus ascertaining the strength of the brine, I felt curious to know the mode of evaporating it, believing it must be very different from that practised in England, a supposition which was confirmed by the singular appearance of the long ranges of sheds used for the purpose. These buildings are scattered over a space of ground nearly a mile in length, they are often as much as two hundred feet long, and about thirty high and broad, being sometimes arranged so as to form three sides of a square. They are well roofed with tiles, but quite open at the sides and ends, being merely composed of upright timbers, placed at intervals so as to support the roof. At the bottom of these sheds a shallow wooden cistern is fixed, about two or three feet from the ground, a similar one being placed about fifteen or twenty feet above it, just under the roof. The brine is first pumped into the upper cistern, where, from the great surface exposed to the air, evaporation immediately commences, and by the very ingenious contrivance of making it pass through a considerable mass of twigs, twisted together into a sort of loose wicker-work, the brine is then dispersed into small drops, and in this form slowly falls into the lower cistern. By passing through a distance of fifteen or twenty feet in this comminuted shape, the process of evaporation is of course greatly accelerated, and the brine remains in the lower cistern till of sufficient strength to be further evaporated by exposure to heat.

The nature of the process will be understood more clearly by reference to the annexed sketch, in which *a* represents the launder by which the brine is supplied from the pit; *b*, the upper cistern; *c*, the mass of twigs through which the brine falls; and *d*, the lower cistern which receives it.



The final process of evaporation by heat, I did not see, but from the appearance of the buildings, suppose it is conducted in nearly the same manner as in this country; although, judging from the taste, the brine when ready for the salt-pans, cannot be more than half the strength of ours. From the great extent of the salt-works in this vicinity, the quantity of salt produced annually must be very considerable.

A short distance from these works, and close on the margin of the Nahe, the bold and lofty group of rocks called the "Rodenfels," forms a striking and magnificent feature in the landscape. They consist of enormous masses of reddish porphyry, rising perpendicularly in a variety of fantastic forms to the height of six or seven hundred feet above the river, and ranging for a considerable distance along the water's edge.

Other trappean rocks, chiefly porphyries, form many bold hills in the neighbourhood, on one of which stands the picturesque ruins of an ancient schloss, or castle, called "Ebernbourg," said to have afforded refuge to Martin Luther, during the early period of the Reformation. The relations of these porphyries with the red sandstone, which borders immediately on them, I had but few opportunities of correctly ascertaining, but should refer them generally to an older date, as the sandstone appears to maintain its horizontal stratification close up to their abrupt and vertical masses. There appears, indeed, little doubt that the porphyritic rocks of this district have chiefly furnished, by their detritus, the materials of this sandstone, as they contain a considerable proportion of quartz, which is seldom so important a constituent in rocks of this nature.

Proceeding towards Bingart, the mountains rise into a well defined chain, having a steep escarpment, and sloping down to a small river; of this circumstance advantage has been taken, in driving up adits to the quicksilver mines in that district, but, from the length of the declivity, they are commenced at a much higher level than the bottom of the valley. Mountainous ranges forming the western dependencies of the Donners Berg, extend from thence southward, to Nieder Moschel, Ober Moschel, and Alzens, including several mines of quicksilver, and also some from which silver is raised. Many coal mines are worked in this tract of country, which includes the extensive coal-basin of the valley of the Glane. The country, though not very fertile, is generally cultivated, and the more elevated portion is covered by extensive forests, which, together with its bold and undulating surface, give it a pleasing and picturesque appearance, and it affords some fine and wide-extended landscapes.

The geological structure of this country is rather obscure, embracing slate, sandstone with veins of cinnabar, the coal formation, new red sandstone, and occasionally trappean rocks, the mutual relations of which are not easily apparent, and the result of my short examination was of course insufficient to determine them with certainty. It appeared to me, however, that the great mass of the mountains consisted of slates, probably belonging to the greywacke class, and that the coal-measures rested unconformably on these slates, being moulded into hollows presented by their upturned edges, and skirted and partially overlaid by the red sandstone, as often happens in England. The true relations of the sandstone, containing the deposits of quicksilver, are very obscure; there is little doubt, however, that it occupies an intermediate place between the coal-measures and the great mass of subjacent slates, answering perhaps to our mill-stone grit, or, which I consider equally probable, it may form beds subordinate to the greywacke slate, and constituting the upper part of that formation, in which case it would be nearly equivalent to our old red sandstone. These, however, I hazard as conjectures only; nothing which came within my observation affording more than probable evidence of the true position of this sandstone, a point which has most probably been already settled by continental geologists.

The coal obtained in this district is bituminous, and of good quality; near Bingart it is procured at the depth of sixteen lachters, or 112 feet; this seam does not exceed two feet in thickness, but it appears that in this vicinity, which forms the northern termination of the coal-field, the beds thin out as they rise to the surface. At Saarbrucke, a seam of coal is worked which is from ten to twelve feet in thickness, but this belongs to the rich coal-field of the Sarre, which forms a separate basin from that of the Glane, before noticed, and lying some distance to the south of it.

Having now given a slight sketch of the geological structure of the tract of country in which the deposits of quicksilver occur, so far as it came under my observation, I proceed to notice the mines themselves, those which I visited being chiefly situated, as before noticed, in the vicinity of Bingart, Nieder Moschel, and Ober Moschel, and therefore in the mountainous country bordering on the Donners Berg, and lying rather to the north-westward of it.

The deposits of quicksilver are chiefly worked in the sandstone formation before noticed, but appear to extend in some places into the slate or shale, as at the Limberg mine near Bingart. The sandstone is of a pale brownish or greyish colour, usually very compact, and approaching the nature of hornstone. In some of the mines, and especially in the Stahlberg mine, near Ober Moschel, I was much struck with its occasional resemblance to the quartz rock of the Lickey-hill, in Worcestershire; indeed, many of the pieces which I picked up on the surface of the mine, were scarcely distinguishable from it in mineral character. This resemblance, together with the frequent occurrence of trappean formations in many parts of the district, suggested the idea, whether this sandstone may not, like that of the Lickey, have been altered by igneous action, and whether, supposing it to belong to the coal series, its present compact texture may not have resulted from that cause. Numerous thin and irregular joints traverse this sandstone, and it is chiefly in them that the mercury is lodged; although disseminated likewise throughout the mass, these joints furnish, therefore, an additional feature of resemblance to the Lickey quartz rock. In some of the mines I observed strata of a much softer description, and of

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* We reprint the above article, with additions by the author, from the "Mining Review," No. IX., believing that it may prove interesting to many of our readers. —Ed. M. J.]

† It appears rather singular that a country so eminently gifted with almost every variety of mineral produce as Great Britain, should be entirely destitute of quicksilver, more especially as the coal formation, in which that metal is most commonly found, is here so largely developed. There is, however, a remarkable passage in Bishop Watson's "Chemical Essays," in which he mentions the circumstance of quicksilver having been found in a native state, at Berwick, in Northumberland, but I have never seen this curious circumstance described, or even alluded to, in any other work. The situation of Berwick, among rocks of the carboniferous series, gives probability to the statement, and further information regarding such a singular mineralogical fact, is highly desirable: in the hopes of eliciting it, I have here mentioned the circumstance.

‡ Russia produces a still larger quantity of the precious metals, but the supply is, I believe, partly derived from her Asiatic dominions.

an argillaceous nature, contained in the sandstone, a circumstance certainly unfavourable to the above supposition.

The mode in which the quicksilver occurs, is very remarkable, being neither a bed nor a vein, but forming rather what may be termed *a metalliferous channel of ground*, this channel being of considerable width and extent.

The direction of these channels approaches north and south, but in some mines there are two or more crossing one another; their width is quite undefined, but they are worked from five or six feet in width to twenty or thirty, and appear to descend almost perpendicularly into the rock. One or more thin fissures, of a fluccany nature, exist in these channels of ground, and seem to be chiefly depended upon by the miners in guiding their researches, though in themselves unproductive. This fissure is termed a *kleft*, and where I observed it, was merely a thin irregular crack, filled with reddish clay.

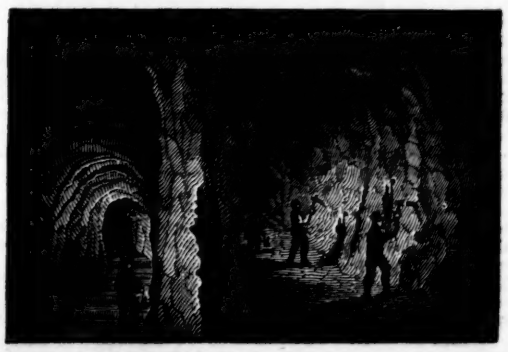
The quicksilver, as before noticed, occurs chiefly in the joints of the rock, which appear to be more or less filled with it, in the neighbourhood of the *klefts* for an indefinite width and extent; but whether it is of contemporaneous formation with the rock, or whether deposited in cracks which had subsequently opened in it, I was unable to determine, although from its general dissemination, the former is most probable. The length of productive ground in some of the mines, appeared, from the extent of the workings, to have been as much as half a mile, and I was informed that its vertical extent was occasionally from twenty-five to thirty lachters (175 to 210 feet). The actual depth to which the quicksilver extends appears to be unknown, but I believe none of the mines in this district exceed 300 feet in depth. The ore from which the quicksilver is chiefly obtained, is cinnabar, which varies from a bright to a dull red colour, traversing the mass of the rock in all directions, and sometimes very abundantly, but its distribution did not appear to me to follow any certain law, or to be exclusively limited to any particular strata, though such may be the case.

Specimens often occur, of considerable richness, which contain, along with the cinnabar, a good deal of native quicksilver, disseminated in small globules, often about the size of a pin's head; these, however, bear an exceedingly small proportion to the poorer ores, or rather masses of rock containing veins and disseminated particles of cinnabar. Rich stones of ore, such as are often found in the most productive parts of the deposits, will yield from five or six to eighteen or twenty per cent. of quicksilver, and picked specimens as much even as fifty or sixty per cent.; but taking the general average of the stuff raised from the mines, I was informed the produce was only equal to about one per cent.; this, however, did not appear well ascertained, and has been considered too low. It will be seen, therefore, that quicksilver considerably resembles the precious metals, as regards the mode in which it has been disseminated by Nature throughout the mass of the enclosing rock or veinstone, a circumstance to which (in addition to its limited distribution) must be ascribed the comparatively high price which this metal always obtains.

In the vicinity of Bingart the quicksilver mines are situated on the declivity of a mountain, at an elevation of about a thousand feet above the valley, and are, in consequence, worked chiefly by adits, which enter the mines at depths varying from twenty to thirty lachters. In some of these mines the workings above the adit are considerable, and sinks have gone down for a depth of nearly twenty lachters below. These mines are chiefly opened in the sandstone, but one of them as before noticed appears to extend into the slate; they are worked to a limited extent, and a small quantity of cinnabar is raised; immediately adjoining them is an old smelting work, now in ruins, but which must have afforded the means of reducing a large quantity of quicksilver.

The Stahlberg mine, one of the most important in the district, is situated near Ober Moschel; it is very ancient, and extensively worked, the depth being near three hundred feet, and the longitudinal extent of the excavations considerable. It is situated on very elevated ground, and drained by an adit, which comes into the workings nearly at the deepest point; there are no shafts, access being afforded by levels driven into the side of the mountain. This mine is still worked to some extent, and produces a good deal of cinnabar, although the present returns are very small compared to what they must have been when the workings were regularly and effectively prosecuted. The prevailing rock is a compact sandstone or hornstone, of a similar nature to that before noticed, but containing occasionally softer argillaceous strata.

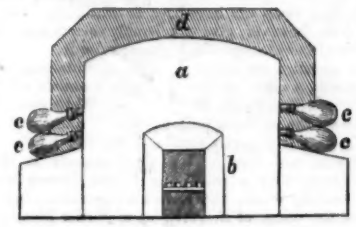
The great magnitude and extent of the excavations, and the peculiar manner in which they have been formed, renders the appearance of this mine exceedingly singular and picturesque. We entered it by a level driven into the upper part of the mountain, and after proceeding a short distance, reached some of the upper excavations, from which the quicksilver had formerly been obtained. They consisted of a series of large irregular chambers, fantastically over-arched, and of course communicating with each other. The height is often considerable, and the width, in some cases twenty or thirty feet, being regulated by the distance to which the deposit of quicksilver had been worth working. The access to these chambers, and from one to another, is by rude staircases, hewn in the solid rock, furnishing a novel and easy mode of subterranean communication, differing entirely from anything which we see in the mines of this country. Our party consisted of seven or eight persons, and the unusual light, and broad shadows produced by so many lamps, the spaciousness and irregular forms of the excavations, and the perspective of the rude winding steps by which we descended into the various chambers of the mine, formed altogether a scene more remarkable and more picturesque than anything of the kind I had ever previously witnessed, and of which the annexed sketch may, perhaps, convey some idea.



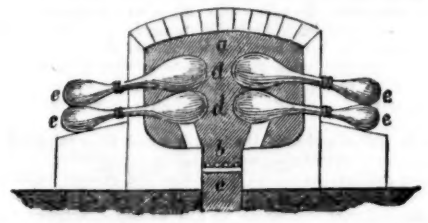
About five and thirty men are now working in this mine, although I should suppose that two or three hundred had formerly found employment there. The present operations are chiefly confined to breaking down old pillars and masses of orey ground left standing in some parts of the mine; even from these sources some good produce is obtained. The cinnabar is very generally disseminated through the rock, but abounds rather more in some of the strata than others. The mercurial vapours of the mine did not produce any unpleasant effect during our short stay, although leaving a slight reddish deposit on the skin, and the miners themselves appeared but little affected by them, indeed, from the spaciousness, dryness, and good ventilation of the workings, and easy mode of access, I should imagine this mine, notwithstanding the existence of noxious mineral vapours, to be scarcely more unwholesome than the deep and hot mines of Cornwall, where the evils, although of another class, are perhaps nearly as oppressive and unfavourable to longevity.

The Landsberg mine lies two or three miles distant from the Stahlberg, on the declivity of a lofty mountain, covered with wood, and crowned with the ruins of an ancient castle, forming a situation unusually interesting and picturesque. A lead and silver mine, called Seelberg, is worked in this vicinity; it is situated on elevated ground, the rock including the vein being a bluish coloured greywacke slate. The Landsberg mine appears equally extensive with the Stahlberg, and has been worked in a very similar manner, but is at present wrought only on a limited scale. I had here an opportunity of observing the mode of reducing quicksilver, which, from the nature both of the metal and its combinations, is one of the most simple operations of metallurgy, consisting merely of a process of distillation. The furnace in which it is performed is about twenty-four feet long, twelve broad, and six or seven high; fires are placed at each end, the heat passing first through the body of the furnace, and then going off by a cross flue in the middle. Forty-eight iron retorts (twenty-four on each side) are arranged in the interior of the furnace, in two rows, one above the other, so as to be exposed to the heat in its passage from the fires to the cross-flue in the middle by which it escapes; the necks of these retorts pass through apertures in the wall, so that smaller retorts on the outside of the furnace can be luted on to them.

These particulars will probably, however, be better understood by reference to the annexed sketches; the first of which represents an end view, and the second a cross section of the furnace. In reference to the former, *a*, represents the body of the furnace (exterior), *b*, the fire-place, *c*, *c*, the outer set of retorts arranged in two rows, one above the other, and *d*, the cross-flue in the middle.



In the cross-section, *a*, represents the body of the furnace (interior), *b*, the fire-place, *c*, the ash-pit, *e*, *e*, the small retorts, placed outside the furnace to receive the mercurial vapour, and *d*, *d*, the large retorts, arranged in the body of the furnace, in which the ore is exposed to heat.



After thus explaining the construction of the furnace, the process of reduction will require but little notice; the ore, being carefully picked and broken up, to separate the worthless matter, is reduced to powder, and put into the large iron retorts, together with a certain quantity of pulverised quicklime, and exposed for some time to a moderate heat, which drives off any moisture that may be contained. The outer set of retorts is then luted on, and a stronger degree of heat, continued for some hours, decomposes the cinnnbar; the sulphur then becomes acidified, and combines with the lime. The quicksilver being thus liberated, is at the same time volatilized, and passes off in the form of vapour, into the small retorts outside, where it soon becomes condensed, and assumes a metallic form.

In concluding this brief notice of the Bavarian quicksilver mines, I may observe, that they are now in possession of an English company, and are, therefore, likely again to be worked with effect, and, if under good management, I have reason to believe, with success. They possess the advantage of being drained to a great extent by levels, and are therefore almost free from water cost, while coal, for the reduction of the ore, may be obtained close in their vicinity. From the nature of the deposits, it appears to me that they are capable of yielding an immense mass of rock, more or less impregnated with quicksilver, and from the ease with which this produce can be obtained, and the occasional richness of some portions of the mass, these mines seem to offer a fair field for enterprise. Independently of what the old workings may produce, attention should also be given to new discoveries, and making trial of any portions of the deposits, which may not formerly have been thoroughly explored.

The mode of working which suggests itself to me, is similar to that pursued in some of the poorer mines in this country, where, by skilful arrangements of machinery, &c., a large quantity of stuff is broken underground, and cheaply delivered at the surface. By thus considerably increasing the returns of ore, and proportionally augmenting the power of reduction, combining this extension of the works with the greatest possible economy in all the processes, it appears very probable the mines may again be placed in a prosperous state.

EXTRACTS FROM FOREIGN SCIENTIFIC WORKS.

No. XV.

ON THE BROWN AND RED IRON ORE IN GRANITE AND SLATE, IN THE DISTRICT OF SCHWARZENBERG AND SCHNEEBERG.

We extract the following account of a remarkable species of mineral deposit, which produces large quantities of ironstone in some parts of Germany, from a work to which we have been frequently indebted before, the "Archiv für Mineralogie, Geognosie, Bergbau, und Hüttenkunde," conducted by Dr. C. J. B. Karsten:

In a former volume of your valuable miscellany you observe, that the appearance of large masses of brown and red iron ore, between granite and slate, in the Erzgebirge, was a remarkable circumstance, which merited a careful description. Having mentioned these strata in only a cursory manner on the previous occasion, I take leave to submit the following remarks, which have not, however, any pretensions to being very complete. The annexed geological map will give, notwithstanding, a clear representation of the general relation of the stratification in the vicinity of Schwarzenberg and Schneeberg. A glance at this map will show, that in the above district there are situated six isolated summits of granite of unequal size, some surrounded with a continuous, others with an unconnected border of gneiss, or greenstone slate, but all situated in the midst of mica slate, which dips to the north-west, without any relation, for the most part, to the granite summits near it. The characteristics of these primary slates are too well-known to need any observations here; and yet I cannot avoid noticing the porphyrytic gneiss at the Schwarzwasser, near Schwarzenberg, and the greenstone slate, containing magnetic ironstone, with beautiful compact red felspar, at the Steinberg, near Albernau, as being analogous to the hälleflinta (a close combination of compact felspar and quartz) at the Danemora mines of Falun.

At Due, the gneiss and mica slate contain layers of slaty quartz, mingled with iron and impregnated with oxide of tin. With regard to the places where iron ore appears, I consider them as veins of more recent formation, and as rocky fissures filled from above. These fissures generally preferred the easier way through the granite and slate formation, and yet continued their course unobstructed in the gneiss and mica slate, probably influenced by a similar cause, producing solidification or clefts, as is the case at the Rothenberg mine, near Erlahammer. That the iron was deposited in the granite, and, moreover, in great breadth and richness, is proved by the Spitzleiten lode, near Burckhardtsgrün, and the Schwalben vein, near the Schneeberg, Filzteich. Its general direction is from south-east to south-west, and its breadth varies from a quarter of a fathom to three or four fathoms. The chief substances with which these fissures are filled, are hornstone, quartz, jasper (seldom yellow in the Schwalben vein), sulphate of barytes, calc-spar rarely compact, fibrous and ochrous, red, brown, and black iron ore (remarkably fine at the Spitzleiten mines), brown spar, less frequently iron and copper pyrites, and very rarely phosphate of copper, the latter discovered by the mine councillor, Friesleben, in the Rothenberg. Here also the so called cubic quartz is met with. I have likewise found compact red iron ore, in perfect spherules, on the Schwalben lode. The hornstone contains a great number of quartz fragments, and *vice versa* at the Rothen Kamur, it includes also fragments of slate, in many instances of a cellular texture. This hornstone sometimes presents itself in pseudo crystals of calc spar.

In general the lodes are separated by a layer of unctuous clays from the inclosing rock, and these contain various debris, including those of granite or slate, which latter contains porcelain clay. Their points of junction are often the same with those of the pure iron ore, and these concretions may be considered as layers between other strata, having generally a northern direction.

The most abundant and the richest returns of ore were, and still are made, from the Rothenberg mine, near Erlahammer, the Spitzleiten mines, and the Schwalben lode. Equally rich, and perhaps even superior mines, extending through the same formation, lie more in the vicinity of Johanngeorgenstadt, but they are not so well known to me as those which I have described.—*Karsten's Archives*, vol. xix., p. 531.

PROCEEDINGS OF SCIENTIFIC MEETINGS.

[We have just received the following abstract of the proceedings of the Geological Society at their last meeting for the present summer: the delay in its appearance does not, therefore, rest with us.—Ed. M. J.]

GEOLOGICAL SOCIETY.—June 14.

Rev. W. Whewell, President, in the chair.

A letter was read, addressed to C. Lyell, Esq., from Dr. Mc Clelland, who had been associated with Mr. Griffith in the scientific expedition sent by the Indian government, under the direction of Dr. Wallich, to investigate the natural history of the country, and the circumstances under which the tea-plant is found wild in Upper Assam.

Some high land was seen between the channels of the Ganges and Burrampooter rivers, at the foot of the Kossia Mountains, or that portion called the Garrow Hills, rounded knolls are interspersed throughout the partially inundated plain, and are composed of layers of sands, clays, gravels, and boulders, appearing to be the remains of a talus of great extent, which had been partially swept away by the great hill streams. The foot of the mountains is composed of a rock in which Nummulites are found. On ascending the mountain acclivity, over limestone and sandstone rocks, to Cherraponji (a sanatory station established at an elevation of above 5000 feet), and reaching a height of 1500 feet above the level of the sea, the author discovered a stratum filled up with shells and marine exuviæ, two feet thick, reposing upon sandstone, and covered by soil which resembled a well-defined marine beach. Several hundred specimens were, and many thousands might have been obtained. The species were about 100 in number, and when compared with about an equal number from the Paris basin, no less than twenty species were found to be identical in the two collections.

The sandstone higher up the mountains than this deposit, contained the impressions of shells and other organic remains. On this sandstone reposes a deposit of compact limestone, from which thirty-seven species of shells were extracted, consisting of species of Trochites, Cerithiæ, Modiolæ, and of Pileolus Plicatus of Sowerby. On this formation reposes a bed of coal to the depth of about twenty or thirty feet, in which remains of an exogenous plant were found.

On crossing the mountains towards the centre of the group, the sandstone on which the limestone and coal rest at Cherraponji, was found for fifteen or eighteen miles, forming in horizontal strata lofty undulating lands. Beyond this the strata displayed marks of confusion, and in the first deep river valley, a mass of greenstone was found with the adjoining sandstone tilted up in highly inclined tabular masses, and compact and glossy in the neighbourhood of the greenstone.

Beyond this (the Boga Pany) all traces of sandstone disappear, and the centre of the mountains from Muflong to the highest ridges is composed of syenite. Granular quartz, in slaty and vertical strata, is found in contact with this, and displaying progressive changes to the sandstone. The northern side of the mountains, from Muflong into Assam, is composed of granular foliated felspar, penetrated by quartz veins. Extensive beds of syenite and central nuclei of granite are found as far as the valley of Lower Assam—hot and salt springs were met with. It was at the base of the mountains that fossil bones were observed by the late Mr. Scott. The author also collected about one hundred and sixty species of the animals, chiefly birds, of the forest of Assam, as well as one hundred and twenty species of the fishes of the Burrampooter.

A paper was then read on the remains of a fossil Monkey from the tertiary strata of the Sewalik Hills, in the north of Hindoostan; by Captain P. T. Cautley, F.G.S., Bengal Artillery, and H. Falconer, M.D., Bengal Medical Service.

In this communication the authors minutely describe, and compare with that of the Semnopithecus Entellus, an astralagus which had been found in the fossil state, as already mentioned in the letter from Captain Cautley to Dr. Royle. Though they have for some time possessed this specimen, they were unwilling to risk the announcement on any thing less characteristic than the cranium and teeth. Messrs. Baker and Durand, of the Bengal Engineers, have since found a considerable portion of the face, and the whole series of molars of a quadrumanous animal, belonging to a much larger species than theirs.

The fossil astralagus is that of the right hind-leg, and was sent, as well as that of a recent S. Entellus, with the paper. The former was completely mineralised, having a specific gravity of about 2·8, and appearing to be impregnated with hydrate of iron. Although only a solitary bone of the foot, the relations of structure are so fixed, that the identity of the fossil is as certain as if the entire skeleton had been found. This astralagus closely resembles, in size and form, the Semnopithecus Entellus, but the points of difference are sufficient to leave no doubt about a difference of species.

In the debris or different beds of the formation which yielded the quadrumanous fossil astralagus, the authors have also discovered the remains of a species of Anoplotherium, also of the Crocodile and Gavial, which now inhabit the Ganges. The camel, antelope, and anoplotherium, have been exhumed from the same bed. The elephant, mastodon, hippopotamus, rhinoceros, hog, and horse, have been found in the same formation with the Sivatherium Giganteum, armed with four enormous sheathed horns; with these have been found several carnivora. Of the feathered tribe there are huge Grallæ. Of reptiles, besides those already mentioned, there are other crocodiles and testudinata, both of enormous size.

LONDON ELECTRICAL SOCIETY.

At a general meeting of the society lately held, it was resolved, "That the weekly meetings having been adjourned until Saturday, the 7th of October next, the committee be requested to prepare a report for circulation."

In pursuance of the above resolution, the committee have prepared a report, of which the following is a brief abstract:—

"The committee announce that the object for which the society was formed will be fully carried into effect; and observe, that the views of the society have only to be made public to insure its ultimate success.

"It was their intention to make a selection from the papers read at the weekly meetings, in order that they might be printed and circulated among the members. The committee, however, for the present, are induced to delay the publication from some of the members having intimated their intention of presenting papers after the recess, comprising new but important facts in Electrical Science."

We select the following from the several valuable papers read at the weekly meetings, and enumerated in the report as being of more particular interest to our readers—abstracts of some of which will appear in our future numbers.

"On the same case under different circumstances, producing the varied phenomena of the different sciences of Electricity, Galvanism, and Magnetism.

"On the theories of Franklin and Du Fay, as regards single and double fluids, developed by friction or electric machines.

"On secondary electric currents and on their influence in certain arrangements of apparatus.

"Extract of a letter from Lieut. Morrison, R.N., dated Cheltenham, June, 1837, describing an instrument which he terms a Magnet Electrometer; it not only indicates the kind but also the degree of Atmospheric Electricity.

"On a new experiment with magnetic battery, by which a continuous line of sparks can be produced.

"An original letter, dated November, 1822, from Andrew Crosse, Esq., to Mr. K. Spencer, describing the mode in which he then insulated his atmospheric apparatus.

"A paper entitled 'An Experimental Investigation of the influence of electric currents in soft iron, as regards the thickness of the metal necessary for the full display of its magnetic action, and how far thin pieces of iron are available for practical purposes.'

"Extract of a letter from Andrew Crosse, Esq., to W. Leithead, Esq., dated Broomfield, near Taunton, August 4, 1837, describing some interesting results obtained by him in producing crystals by transfering the electric energy from the zinc and copper plates to other substances, not metallic, in contact with them.

"On a new mode of increasing the power of the shock from a coil of wire when acting upon a voltaic current."

It appears from the report, that any member desirous of carrying on a series of experiments, would, on mentioning his intention, and describing the nature and object of the proposed experiments in writing to the committee, be immediately afforded the necessary facilities.

The committee announce that in consequence of the increased number of members and visitors attending the weekly meetings, they have been compelled to seek a larger room for their accommodation. The council of the Society for the Illustration and Encouragement of Practical Science have obligingly permitted the future meetings to be held in their Lecture Room; in addition to which the council have liberally offered the society the use of their Electrical Apparatus.

The general weekly meetings will be resumed on Saturday, the 7th of October, at seven o'clock.

We subjoin the following notes from the rules and regulations:—

"The society to consist of resident and non-resident members.—The subscription of a resident member being for the first year *two guineas*, and that of a non-resident *one guinea*.—Visitors may be introduced and will be permitted to join in the discussion.—The society meet every Saturday evening, at seven o'clock, for the purpose of conversation, and at eight o'clock the chair is taken."

FRENCH STATISTICS.

The most elevated city in France is Pontarlier, on the borders of Switzerland, which is situated 887 metres above the level of the sea, which, taking the metre at nine-tenths of a yard, makes 2394 feet. Gex, in the department of l'Ain, is 667, Rhodes 632, Lyon 299, the Pantheon at Paris 60, Lille 24, Bordeaux 9, and Dunkirk 8 metres above the level of the sea.

The two highest mountains in France are the Pic des Arsines, in the Hautes Alpes, and the Pelvoux, in the Isere, both belonging, properly speaking, to the Alpine chain; the summit of the former is 4105 metres, the latter 3934 above the sea. Both are higher than the highest among the Pyrennean summits, of which the Cylindre has an elevation of 3322 metres, and the Maladetta 3312. The inferior mountains of France are the Paslia Orba, Corsica, 2634m.; the rock of Malpertus, Lozere, 1680m.; the Hort de Dieu, Cevennes, 1565m.; the Cantal, 1935m.; the Mont d'Or, Auvergne, 1886m.; the Mont Balon, Vosges, 1429m.; the Boussiore, Loire, 1004m., &c.

The inland navigation of France, composed of 8255 kilometres of rivers, and 3699 kilometres of canals—in all, 11,954 kilometres. The kilometre is equal to 1000 metres, and 11,954 French kilometres are about 7429 English miles.

Seventeen departments of France are entirely destitute of inland navigation. Amongst these are the level plains of the Orne, the Indre, and the rich department of the Eure and Loire.

The royal roads now form a total length of 34,511 kilometres, or 21,387 English miles. Of these, on the 1st of January last—

24,717 kilometres were in good condition,
5,815 kilometres were in course of repair,
3,942 kilometres were entirely neglected.

The departmental roads exceed the royal roads in length only by about 2000 kilometres.

The by-roads *(chemins vicinaux)* are in number 468,527, and their joint length is estimated at 771,458 kilometres, leaving an average length to each of about half a league.

The whole superficial territory of France amounts to 52,768,600 hectares. (The French hectare equals four-tenths of an English acre, consequently the superficies of France comprises 21,107,440 English acres, or 32,980 square miles). Seven millions of hectares are described as of a rich soil, and the general distribution of the land is estimated as follows:—

	Hectares.
Arable	25,000,000
Pasture	4,834,000
Vineyards	2,135,000
Woods	7,422,000
Waste Lands	7,799,000
Buildings, roads, cities, &c.	1,466,000

The Marne is the department possessing the greatest amount of arable land, of which it comprises 614,000 hectares; the Cantal is the richest in pasture, of which it comprises 221,000 hectares; the greatest extent of vineyards is found in the Gironde, 138,000 hectares; the most extensive woods are in the department of the Nievre, of which it contains 239,000 hectares, or more than one-third of its whole superfices.

Another curious table is that which shows the number of hands into which the territorial surface of France is divided, displaying the extent to which the revolutionary principle of the division of property has already acted. There are no less than—

5,205,411	properties paying a land tax of less than..	5 francs.
1,751,994	between	5 and 10
1,514,251		10 and 20
739,206		20 and 30
684,165		30 and 50
553,230		50 and 100
341,159		100 and 300
57,555		300 and 500
33,196		500 and 1000
13,361		1000 and upwards.

10,893,528

From this table it would appear that there were upwards of 10,000,000 of landed proprietors in France, each owning, on an average, about two acres; but it must be borne in mind that several properties frequently belong to one proprietor, and it would therefore be impossible, from the foregoing table to make any estimate approaching to accuracy, of the real number of landowners in France.

The returns of the number and kind of buildings on which the door and window tax has been paid have furnished materials for the following tables:—

The houses and habitable buildings in France amount in number to	6,649,551
Wind and water mills	82,946
Forges, furnaces, &c.	4,425
Manufactories, &c.	38,314
Buildings belonging to the Government, such as palaces, barracks, hospitals, &c.	98,000

The general registration of all landed properties in France, enables the compilers of the work before us to furnish the exact extent to which property is continually changing hands. Every year, on an average, the capital engaged in these mutations amounts to three thousand millions of francs, or 120,000,000*l.* sterling.

Filling up of Lake Superior.—This mighty lake is the largest body of fresh water in the known world. Its length is four hundred and eighty miles, and its breadth one hundred and sixty-one—its circumference about one thousand one hundred miles, and its depth nine hundred fathoms. Its waters are remarkable for their unrivalled transparency. About one thousand streams empty themselves into this lake; sweeping in sand, primitive boulder stones, and drift timber, which sometimes accumulate so as to form islands in the estuaries. A lignite formation, indeed, is said now to be in progress. Within a mile of the shore the water is about seventy fathoms: within eight miles one hundred and thirty-six fathoms. From the above causes the lake is gradually filling up. Lake Erie, from similar causes, is also filling up. This sheet of water is two hundred and seventy miles in length, sixty in breadth, and two hundred fathoms in depth. It is gradually becoming shallower. Long Point, for example, has in three years gained no less than three miles on the water. On its southern shore, serious encroachments have been made in many places. For a considerable distance above the mouth of Black River, the bank of the lake is low and without rock. Thirteen years ago the bank was generally sloping, with a wide beach; now the waves beat against a perpendicular bank, which, from continual abrasion, often fall. From one to three rods in width are worn away annually.

Hailstones at Calcutta.—While we are writing (four p.m.) a passing cloud is pouring down a thick shower of large hailstones. The shower seems to be of very limited extent.—*Calcutta Courier.*

ON THE ORIGIN OF MOUNT ETNA.

BY M. ELIE DE BEAUMONT.

It has been ascertained that the greater number of the appearances of flames which accompany the volcanic eruptions, are only the effect of the rays of light which emanate from the incandescent lava, and which are reflected by the molecules of vesicular vapor, and of dust disseminated by the eruption in the atmosphere. In consequence of this observation, doubts have been raised as to whether volcanos, in any case, produce real flames. These doubts have been already removed by Sir H. Davy in regard to Vesuvius, where he ascertained, during a small eruption, the existence of a real jet of flame; and we ourselves have observed on Etna, incontestible volcanic flames. Having left the *Casa inglese* about an hour and a half before daybreak, in order to ascend to the edge of the crater, the feeble light of the stars enabled us to perceive, on the commencement of the acclivity of the upper cone, a white space whose colour was caused by the alteration of the rocks, and by saline efflorescences having a very styptic taste. In the midst of this space, at several points, we distinguished pale and scarcely luminous flames, which seemed to issue from the earth; they occupied the orifices of sevral irregular openings, which were from one to two yards in width, and were only the enlargements of a tortuous crevice. These flames were evidently produced by a gas disengaged from the crevice, and which did not find the oxygen necessary for its combustion till it reached the external air. The combustion took place almost exactly at the level of the surface of the ground. The flame rarely rose to the height of a yard; it produced a sound somewhat intermittent, pretty analogous to that of several lighted faggots, or rather that which is heard at the bottom of a blast-furnace when the blowing apparatus is badly constructed. The gases produced by the combustion did not impede the breathing, and had a strong odor of sulphurous acid. Sulphuretted hydrogen was also perceptible, but I did not recognize the odor of muriatic acid. Every circumstance, then, announced that the flame was supported by sulphuretted hydrogen, and afterwards, when the sun lighted up the mountain, a long bluish cloud was seen taking its rise from that particular point.

In the interior of the great crater I found several portions of snow, but from many other points of its angular bottom there issued hot vapors, having a whitish colour, more or less dense, composed chiefly of watery vapor, but having nevertheless a strong odor of sulphurous and muriatic acids; one or the other of these acids predominated alternately. The surfaces across which the vapors were disengaged were in part covered by saline efflorescences, which were sometimes white, and sometimes coloured of an orange-yellow tint by the chloruret of iron, or of a canary-yellow by particles of lava altered by the acid vapors. In some fissures I found white fibrous gypsum, mixed with altered pulverulent yellow lava in which some small nodules of sulphur were disseminated.

The above account of the observations of this distinguished geologist is followed by a statement of his theory of the formation of the mountain. After alluding to the changes of form that have resulted from the frequent production of extensive longitudinal fissures by the earthquakes that accompany or precede an eruption of the volcano, also to the streams of lava that find their exit through these fissures; to the unequal elevation of their sides by the expanding force below, he draws the conclusion that the foundations of Etna are not immovably fixed, but are undergoing frequent changes. Guided by these considerations, and in addition, observing the extreme slowness with which ejected matter is capable of elevating the central peak, and the improbability, from their structure and situation, that the layers composing the mountain are in the position they were originally accumulated, the author arrives at the following deductions.

The surface formerly nearly flat, has been first repeatedly fractured in various lines having a nearly constant direction. The melted matters have been poured out through the fissures thus produced, and their fluidity must have been nearly perfect, for they have flowed through rents of very inconsiderable breadth. These products were then spread on both sides of the fissures, in thin and uniform masses, similar to those composed of basalt, which in so many different countries, and especially in Iceland, are superimposed above one another, forming vast plateaus whose surface remained always nearly horizontal, in consequence of the subdivision of successive lines of eruption on an extensive space. The eruptions were, like those of the present day, accompanied by disengagements of elastic fluids, which, issuing like the lava itself from the whole extent of the fissures, carried along with them scoriæ and cinders. These scoriæ and cinders falling back like rain, both on the lava and on the neighbouring spots, produced those uniform layers of fragmentary substances, which alternate with the layers of melted matters. But at one period, it would appear that the internal agent which had already fractured so frequently the solid surface, having doubtless exerted an extraordinary energy, broke up that surface, upraised it, and since that time Etna has existed.

Village Lighted by Natural Gas.—The village of Fredonia, in the western part of the state of New York, presents this singular phenomenon. I was detained there a day and had an opportunity of examining it at leisure. The village is forty miles from Buffalo, and about two from Lake Erie; a small but rapid stream, called the Canadoway passes through it, and after turning several mills discharges itself into the lake below; near the mouth is a small harbour with a lighthouse. While removing an old mill which stood partly over this stream in Fredonia, three years since, some bubbles were observed to break frequently from the water, and on trial were found to be inflammable. A company was formed, and a hole an inch and a half in diameter, being bored through the rock, a soft fœtid limestone, the gas left its natural channel and ascended through this. A gasometer was then constructed, with a small house for its protection, and pipes being laid, the gas is conveyed through the whole village. One hundred lights are fed from it more or less, at an expense of one dollar and a half yearly for each. The flame is large, but not so strong or brilliant as that from gas in our cities; it is, however, in high favour with the inhabitants. The gasometer, I found on measurement, collected eighty-eight cubic feet in twelve hours during the day; but the man who has charge of it told me that more might be procured with a larger apparatus. About a mile from the village, and in the same stream, it comes up in quantities four or five times as great. The contractor for the lighthouse purchased the right to it, and laid pipes to the lake; but found it impossible to make it descend, the difference in elevation being very great. It preferred its own natural channels, and bubbled up beyond the reach of his gasometer. The gas is carburetted hydrogen, and is supposed to come from beds of bituminous coal; the only rock visible, however, here, and to a great extent on both sides along the southern shore of the lake, is fœtid limestone.—*Brewsters Journal.*

Quality and Economy of Coal.—The qualities of coal are almost as various as are the depths and thickness of the mines from which it is procured. The most imperfect and least bituminous is what is called the *bass* or *bone* coal, which is open in texture, more or less earthy, and splinters into irregular longitudinal fragments. This coal is applied to the purpose of heating coal or other common steam-engines and furnaces. The *cannel*, which is extensively mined along with the other kinds, is applied to household or other purposes where a speedy and brisk flame with much light is required. The purest is procured from near Haigh Hall, in the vicinity of Wigan, and it nearly approaches jet in fineness of texture; but it is also very splintery and crystallized in the Clifton and Worsley mines, and at Blackrod. The *slate* or compact black coal, which is the most important and valuable, is highly bituminous, and contains very little asphaltum, therefore takes but little when burning, but affords a great heat and a steady white flame. The best is reckoned to be from the *Three-quarters* mine in Hulton, which lies under the *cannel* mines; but excellent coal of the same variety is procured at Blackrod, in Lever, Clifton, and in several other mines. In some rare localities a beautiful *iridescent* coal is found, displaying all the prismatic colours in an intense degree. To take an instance how the varieties lie in one mine of about seven feet in depth, I gave the order of their superposition from one of the mines of the Worsley tunnel near Bolton:—1, *Bass* coal, nine inches; 2, cannel, three feet six inches; 3, blend, six inches; 4, slate coal, eighteen to twenty inches. A thin seam of ferruginous shale lies often over the *cannel*, and is frequently a great depository of vegetable remains. The cleavage of pure coal, such as *cannel*, is always perpendicular to the stratification, whatever may be the inclination.—*Black's Sketch of Bolton and its Neighbourhood.*

Extraordinary Present.—The museum of the King's College received a present from the Bank of England of 20,000,000 of Bank of England notes, reduced to the size of a small hat, after being destroyed by fire.

KYAN'S PATENT, FOR THE PREVENTION OF DRY-ROT.

The evil arising from the destructive effects of dry-rot in timber has long been deplored by all persons connected with nautical affairs. The merchant and the naval service have equally suffered, and all descriptions or craft, from the humble coasting-sloop to the line-of-battle-ship, have been doomed to condemnation if once under the influence of this insidious enemy. The immense losses thus entailed, and the great frequency of the occurrence of such losses, together with the expense and anxiety resulting from the necessity of frequent examinations, urged the attention of chemists and others to the subject, with the view of finding some means of preservation. Numberless experiments have from time to time been tried, and more than one specific has been put forth with the confidence of absolute certainty. Speedy failures, however, and those sometimes at periods when a successful result had been confidently anticipated, threw a damp over the hopes that had long been cherished, and it was feared that the disorder was one over which science had no power. At length Mr. Kyan, after long attention to the subject, made a discovery which has stood the most severe tests, and has ever since been advancing in reputation. It consists in saturating the timbers, cordage, &c., with a solution of corrosive sublimate—for which solution, in the proper proportion for the purpose, Mr. Kyan has obtained a patent. The preparation has been subjected to tests of four or five times the duration and severity that any other process has ever been able to withstand; and in no one instance, out of the numberless experiments which have been tried, has it failed. In fact, every endeavour has been made to produce dry-rot in the timbers saturated with Mr. Kyan's solution, but without effect. The principal trials have taken place at Woolwich, where sound timber, subjected to a few months' durance in the fungus-pit, has generally been found contaminated with dry-rot, and but few of the properties heretofore brought before the public, have preserved the wood for twelve months. Several vessels have been subjected to the process, and the result has been perfectly successful, containing through the firm medium of actual fact all the objections of parties interested in raising doubts.

A few weeks back, the result of an experiment tried in this town by the Anti Dry-rot Company, was made manifest. Of this our contemporary, the *Standard*, gave the following account:—"On Tuesday afternoon, the 8th of August, in the presence of several gentlemen largely connected with the shipping in this port, Mr. C. Horsfall, Mr. Russell, Mr. Hamilton, Mr. Simpson, Mr. Blacker, Lieut. Land, R.N., Mr. Carr, the company's agent, &c. A pit, formed after the plan of the Woolwich fungus-pit, in August last year, was opened. On the 8th of August, 1836, a large hole was dug in the yard, which was surrounded with piles of timber taken from a ship which had the dry-rot in her very badly, and into this hole were thrown a piece of best cokor canvass, a piece of half-bleached common canvass, a piece of three-inch white rope, and several pieces of black birch, English oak, and American pine timber, soaked in the preparation, with duplicates of each of the same materials unprepared; they were then hermetically sealed up, to be kept in that situation for twelve months, to test what comparative effect the dry-rot would produce on each. On taking out the half-bleached canvass, prepared with Mr. Kyan's solution of corrosive sublimate, it was found to be perfectly sound and dry, and free from mildew. On taking out the duplicate part, not prepared, it was found that the texture throughout was rotten, and in some places where it had come in contact with the dry-rot wood, it was mildewed away. On taking out the cokor canvass, which had been soaked in the preparation, it was found to be quite sound and white, and looked quite fresh; whilst the unprepared duplicate was found to be completely rotten. The prepared piece of white rope was next examined, and it was found to be perfectly sound throughout its whole texture; and on untwisting it the fibres appeared quite fresh, and could not be broken by any effort of strength. The unprepared piece of the same rope was then examined, and was found to be damp; in some places where it had come in contact with the decayed wood, it was quite rotten, and had got the dry-rot in its texture. On testing the strength of the fibres they broke with ease, on a tension of about two or three pounds force. Both the prepared and the unprepared timber was found to be unaffected, not having sufficiently long been submitted to the test. The result, so far as the canvass and cordage were concerned, was highly satisfactory to the gentlemen present, and strongly elucidated the value of the preparation. The canvass and timber were again placed in the pit for the purpose of being subjected to another twelve months' trial.

Edible Earth.—New facts are constantly brought forward by the learned men of the continent, to show that the earth eaten in Lapland, as described by Baron de Humboldt, is known to other nations as a species of food. M. Edourd Biot has laid before the French Academy of Sciences, an account translated from the narratives of the missionaries, in the "Japanese Encyclopædia." In China it is called *chi-mien*, or stone flour, and the description is as follows:—"The stone flour is not an ordinary production, for it is a miraculous substance. Some say that it was born in seasons of scarcity; and, in the time of the Emperor Hien Tsong (744 of the Christian era), a miraculous spring came out of the ground, the stones were decomposed, and transformed into flour." The text is here accompanied by wood-cuts, representing the spring escaping in cascades, and the stones separating into filaments, but the latter are too incorrectly drawn, to enable us to form any mineralogical idea of their nature. Another missionary writes, that "in the province of Kiang Si, in consequence of the destruction of the crops by the overflowing of the rivers, a great many people subsisted on the bark of a tree, and others on a light earth, of a white colour, which they discovered in a mountain, but which was not abundant, and people even sold their wives, children, household goods, and houses, in order to procure it."—It appears, that several of the enormous provinces of China consist of open plains, traversed by large rivers, the beds of which are constantly raised by the soil deposited by the water, so that it is necessary to border them with high dykes. If the rivers, as it occasionally happens, rise above the dykes, or break through them, the whole country is inundated, and the usual calamitous circumstances follow. If we add to these disasters, the frequent and widely extended earthquakes which take place in China, those sudden and remarkable changes in the amount or population, which have often excited astonishment, may be easily accounted for.

Coal Mines in Syria.—Coal mines have been discovered in Syria, at Mount Lebanon, from twenty-six to thirty miles eastward of Beyrout, at an elevation of upwards of 2500 feet above the level of the sea. There are traces of coal and many thin strata in various parts of the mountains; previously to this spring three mines had been discovered, of a quality and thickness sufficient to warrant the expense of proving and working them. Since that time another has been discovered, although Mr. Bretell, the Pacha's engineer in Syria, is not yet able to decide upon its value. The seams, on an average, are three feet thick; the coal is of a good quality, and generates steam quickly, but forms clinkers in the bars of the grate, which requires frequent cleaning; it contains much iron pyrites, and, if not properly assorted, is liable to spontaneous ignition. The Pacha has determined to ascertain if it is suitable for smelting the iron ores of Syria, and his Highness is now erecting an experimental furnace for that purpose. Should the experiment succeed, Mohamed Ali will erect iron works in Syria, where the ore is very abundant. Iron ore is found both in Lebanon and Anti-Lebanon, and it is traditionally reported that some of the mines were worked in the time of the Romans. Large quantities of cinder from the ancient furnaces are frequently met with at considerable distances from the mines, generally in places where the evergreen oak flourishes. The mountaineers now smelt the ore with the branches of that tree, and iron thus produced is used for making horse-shoe nails, and for other purposes where best iron is required. No lead ore has yet been discovered in Mount Lebanon, although it is most probable it exists in some part of that range. In the mountains above Adana, in Asia Minor, abundant lead ore has been found; but the extraction of the lead from the ore has proved very difficult. Furnaces have been erected near the mines for the purpose of smelting the ore. Palestine has not yet been scientifically explored; therefore nothing is known of the mineral treasures that country contains.—*Extract from a Private Letter, dated Cairo, July* 23.

A Crowbar a Magnetic Needle.—The following case of natural magnetism has no equal known at present:—"A bed of magnetic iron ore not only magnetized so powerfully the iron instruments used to break it up as to adhere to them in large tufts of the fragments of the iron ore, but a crowbar suspended freely over the iron ore takes the position in the magnetic meridian, and thus becomes a true but gigantic needle."—*Report on the Geology of Maine* (U. S.)

IMPROVEMENTS ON THE DAVY LAMP.

TO THE EDITOR OF THE MINING JOURNAL.

SIR,—In a former letter we called your attention to that valuable property of the Davy Lamp, resulting from some peculiar arrangements in its structure, by which the non-inflammable gases or smoke, generated by the combustion going on within, is made to meet within its exit, and so to dilute or neutralize the fire-damp entering into the lamp to the point of destroying its explosiveness.

We pointed out, moreover, that the peculiar contrivances by which Sir Humphrey Davy succeeded in effecting this desirable object, however admirably calculated to ensure such an end, when the fire-damp surrounding the lamp is in a tolerably quiescent state, are by no means of a character that can be relied upon when it is agitated by any violent current. Aware of the importance of this neutralization, and that a lamp wanting in this respect (however carefully constructed, or however defended against currents,) must, like that of Messrs. Upton and Roberts, be quickly driven out by an internal explosion, and so leave the miner in darkness; our attention was for several years directed towards effecting the desired improvements in the Davy Lamp, without compromising to so great an extent the present usefulness of that valuable invention. Our efforts have, to a certain, but (as we are constrained to believe) a *necessarily* very limited extent been successful; and we think that by detailing some of our experiments, and by pointing out what we conceive to be the limits of improvement of which the Davy Lamp is susceptible, we may not only be of assistance to others engaged in this cause, either by, in some measure, aiding them in their researches, or by otherwise saving them a good deal of fruitless exertion; but that, besides this, we may have the opportunity of paving the way for the introduction of our life lamp, for so long as the minds of scientific men shall continue to dwell upon the possibility of effecting everything by improvements upon the Davy Lamp—improvements of which neither its nature or principles are by any means susceptible—there is the less chance for the introduction of an invention upon a construction altogether different.

We shall feel anxious, therefore, when we shall have occasion to speak of our Proof Davy Lamp, that it may be by no means considered we are recommending such lamp as calculated to supersede the peculiar advantages of the life lamp (where circumstances render the employment of that lamp at all necessary), but simply as a really safe, though useful, and at the same time readily portable lamp, that may be used in combination with it. From our endeavours to improve the Davy have resulted three separate inventions; the first, to which we have given the name of "The Neutralizer, or Close Davy Lamp," is in outward appearance, and particularly at the lower part of its construction, a great deal resembling a policeman's lanthern, being much the same in size, of a cylindrical shape, and having a strong glass lens or bull's-eye inserted about the middle, in a similar manner. The upper part of the lamp is conical, terminating in a pipe, which afterwards divides into two branches of equal bore and length; and each of these branches, after ascending a very little way, is bent or turned downwards, but with a similar and gradual curve. Throughout these curved pipes or branches, forming in fact the chimney, the whole of the smoke is of necessity obliged to escape, and in equal volumes; nor are the pipes scarcely more than sufficiently large to completely effect this purpose; the air passing into the lamp for the support of the flame is admitted through a pipe called the "Suction Pipe, or Air Feeder." This pipe is several inches in length, funnel-shaped at top, and having a stop-cock in the middle of it, care being requisite not to admit a greater supply than is found to be consistent with its object. The small end of this suction pipe, or feeder, being inserted into or affixed by union to the cylindrical part of the lamp, at some distance below the wick, it is afterwards bent upwards, so that its top or funnel nearly reaches up to the top of the lamp, and in such a manner as to become a recipient for one of the curved pipes or branches before mentioned as forming the chimney, and which is made to enter it for a considerable depth.

From the peculiarity of this arrangement, it will be found that the air coming in to supply the lamp *is admitted in quantities proportionally minute, according to the degree of its inflammability*; for no sooner does any considerable elongation of the flame take place, and which is of course accompanied by an increased formation of smoke, as well as by an extra draught, than the natural effect of this increased draught is to draw or suck down through the suction pipe, or air feeder, an extra portion of this smoke (or of the nitrogen and carbonic acid gases) from the chimney, and in such manner to so choke or stop up the feeder, as to prevent the ingress, except of a very minute portion only of the external air, until the flame is again reduced to its proper level. The effect, indeed, is very curious, for the flame keeps rising and falling alternately for some time after the sudden introduction of any inflammable gas, since, in proportion as it is at one instant elongated, it is the next depressed. Internally there are arrangements, so that the air admitted is obliged to go direct to the wick, and there are others to prevent any firing backwards. The suction pipe, or air feeder, being at some slight distance from the lamp, and the smoke consequently being somewhat cooled in its descent, its union with the explosive air is, we have thought, in some slight degree promoted by this circumstance; and so great is the extent of neutralization produced by employing half the smoke in the way described, that the lamp yields only a minimum of light in a pure atmosphere, indeed, it can scarcely be said to yield any light at all, unless the air is somewhat impregnated with carburetted hydrogen, so that it is evident we could go no farther; notwithstanding the great extent, however, of this neutralization, it is insufficient to prevent a tendency towards internal explosion, that is when the lamp is severely tested.

It is true, that by simply inserting a small stop-cock into the remaining branch of the chimney we are enabled at pleasure to throw an extra jet, or even the whole remaining portion of the smoke into the air feeder, and so to overcome this tendency towards internal explosion, and in fact, if the air feeder is not too large, we can so choke it up as to put the light out altogether.

For further experiment, it is desirable to have a second air feeder, in all respects precisely similar to the one already described—its funnel forming also a recipient for the remaining branch of the chimney. By gradually augmenting the volume of smoke, or at other times the volume of air, taking care that the air admitted shall at all times be thoroughly neutralized, *we are enabled to burn almost every mixture of explosive atmosphere*. But the precautions necessary in the management of these cocks must evidently go far to preclude its usefulness for other purposes, than merely as an experimental lamp.

In short, Sir, after all our efforts, and I believe almost every possible modification, with a view to ensure the full action of its principles, we have had this lamp go out, and at other times explode (that is internally) when the transition from one atmosphere to another has been extremely sudden, and at other times we have had too great an elongation of the flame; nor can it escape observation, that by the substitution either of tin or of sheet copper, in order to render it a close lamp, we have foregone completely all the beautiful radiating properties of the wire gauze, and that in process of time the lamp, under such circumstances, must become inconveniently hot. It affords, however, a good illustration of the action of the non-inflammable gases in neutralizing fire-damp, and of our early attempts to accomplish this neutralization in a vessel apart from the interior of the lamp, with a view to obtain a close Davy Lamp that should be proof against currents. Our experiments made in this way, when considered in reference to the lamp invented by Messrs. Upton and Roberts, have naturally led us to the conclusion, although we have never yet tried the experiment, that was any decided attempt made for applying this principle of neutralizing the air in its entrance to their lamp, that although it might not be impossible by such means to overcome in great measure its present tendency towards internal explosion, yet the result would be that we should produce so great an elongation of the flame as to endanger the breaking of the glass, which, in our opinion, must, in great measure, divest the lamp of its radiating power.

The lamp of Messrs. Upton and Roberts has, like the Davy Lamp, qualities *sui generis*, which it is highly dangerous to tamper with.

We are, Sir, your obedient servants,

1, *Queen's-head-lane, Lower-road, Islington.* G. & W. BURSILL.

SAFETY LAMP.—A modification has been given to the Davy Lamp in France. It consists chiefly of making the lamp, instead of a whole cylinder, the half, the part cut away being supplied by a reflector, by which means near double the light is at the disposal of the miner, to throw on any particular spot.

CONSTRUCTION OF RAILWAYS.

The Llanelly Railway and Dock Company are adopting a new mode of constructing the upper works of railways, under a patent granted to Mr. Thomas Parkin, who has delivered several lectures upon the subject in London.

As the subject of railways is generally interesting, and must be especially so to the inhabitants of this part of South Wales, which, through the advancement in science, seems destined to become, at no distant period, a very important seat for the manufacture of iron, we shall not hesitate to give a particular description of Mr. Parkin's plan. The road, being prepared of longitudinal bearers of *Kyanized* oak, or other hard wood, from four to six inches in the base, two at the top, or four or five feet deep, dovetailed into one another, thus forming a continuous line, with uprights, twelve inches long and about three in diameter, screwed firmly at every yard into their bottom, are fixed, at a proper height and level, in trenches dug in the road, from eighteen inches to two feet wide and deep. The trenches are then filled with concrete, composed of gravel, sand, and Aberthaw lime, in proper proportions, when only the top of the bearers is visible on the surface of the road, all the rest being completely buried in and consolidated with the concrete, which immediately sets and hardens, and in a short time becomes a solid rock, the whole length of the road forming, as an engineer who inspected the work said, "an everlasting railway." The foundation being complete, patent felt is laid upon the top of the bearers, whereto bars of iron, two inches wide, and half an inch thick, are firmly screwed, and the road is finished. The dimensions of the trenches must be regulated by the nature of the soil on which the railway is made, while the parties adopting the plan may use wood and iron of any size they think proper. The rails, as at present fixed in iron chairs, mounted on stone blocks, at every yard, form unyielding points of support, and intermediate flexible spaces. The carriages, of necessity, alternately descend below, and rise above, the mean line of progression, and produce concussions on those points, the severity of which is according to the degree of variation from a straight line and the *rapidity* of the motion. At a speed of twenty-five miles per hour, they would occur 733 times in a minute. On the Manchester and Liverpool line, Professor Barlow "found the whole road to tremble;" and the deflection in the rails so great as materially to diminish their strength, in consequence of their being *permanently* fixed in the chairs.

Upon Mr. Parkin's plan, no vibration, of the *least possible* degree, is felt, the bars being screwed to *continuous* wooden bearers, bedded upon an unyielding mass of concrete, of the strength and durability of which cement the Roman roads are irrefragible evidence. Besides, the patent felt, between the iron and the wood is a non-conductor of vibration, and aids in lessening the tremulous motion attendant on carriages running even on a perfect plane. The stone block, in the ordinary mode of construction, being insulated and independent of each other, the preservation of a level surface (even if its attainment were practicable) and of parallelism in the rails, is impossible, as differences in the subsoil must occur; and when a block has sunk, in ever so trifling a degree, below those next it, the rail will either remain in permanent flexure, or be loosened from the chair, or loosen the chair from the block, or hold the block in suspension. The rails and chairs form a series of levers and fulcra, the action and re-action of which are incompatible with permanent stability.

Upon Mr. Parkin's plan, an even surface and parallel lines may be had, with almost mathematical exactitude, which neither the magnitude of the weights passing on the rails, nor the rapidity of their motion, can disturb, after the concrete has acquired a proper degree of hardness. When a block on one side of an ordinary railway has sunk only in a slight degree, while the corresponding one opposite obtains its position, increased weight will, of necessity, be thrown on the former, and its tendency to sink still further, as well as to be forced out of a parallel line be augmented, in the ratio of the sinking. But with Mr. Parkin's rails no such sinking could be anticipated, even were its occurrence possible.

With level parallel rails, scarcely any lateral pressure can be felt, except in curves, where means will be employed to meet the exigency of the case. The absence of a plane and of parallelism in the rails, is the principal, if not the only, cause of lateral pressure, which could do no injury to Mr. Parkin's road, unless it either removed out of its place one-half of the mass of concrete in which the bearers, with uprights a foot long at every yard are buried—made a breach in the continuous line of bearers—forced the strong iron screws, by which the bars are secured to the bearers, from their hold, or burst the bars themselves asunder. As these bars are only half an inch wide, and are thus secured to continuous bearers, they present no leverage for the flanche of the wheel to act on, when any lateral pressure takes place; whereas in ordinary railways, the leverage is considerable (the wheels being elevated the height of the rail, which is four or five inches above the point of support), and produces a corresponding tendency to force the blocks out of a straight line. Upon such an unyielding plane as Mr. Parkin's railway presents, less tractive power, as Professor Barlow has ably demonstrated, is necessary than on rails which deflect between the point of support, while the wear and tear of carriages and engines, and the necessity for limiting their weight, are materially lessened.

A locomotive engine weighs from ten to twelve tons, and subjects the rails to the process of a species of rolling, when they split, and become only of the value of old iron. To such an extent was this the case on the Manchester line, that after five or six years it became necessary to have new ones. The less the vibration and concussion, the less liable are the rails to receive this injury, especially when supported on the softer substances of felt and wood. Moreover, as Mr. Parkin's bars only weigh ten pounds per yard, instead of sixty or seventy, the loss from such injury will be proportionably less. Mr. Parkin's plan may be executed cheaper, even where stone blocks cost little, than any other, and with astonishing rapidity. In most parts the saving, by its adoption, will be fully one-half. It may be applied to collieries and private works, especially in Wales, on very advantageous terms. We understand the plan has been recommended by Mr. Brunel for adoption by the directors of the Great Western Railway.—*Cambrian.*

RAILWAY BETWEEN ENGLAND AND SCOTLAND.—Our readers will recollect that some months ago a number of our spirited county gentlemen associated themselves together, and set on foot a subscription for the purpose of obtaining a scientific survey of the line in the Annandale district, with the view of ascertaining and satisfactorily pointing out the superiority of this course as a portion of the Great Western Railway for connecting the North of England with Edinburgh and Glasgow. The committee met, with Mr. Locke, engineer, on Tuesday week. The meeting discussed with Mr. Locke the general subject of a railway communication between England and Scotland, and after the various proposed lines had been considered, came to the conclusion that if the country between Beattock and Lanarkshire, by the valley of the Evan, was found, on a more minute survey than hitherto, to be practicable, that route became in every point of view the only feasible great line of railway. With regard to this line from Carlisle by Beattock and the Evan, Mr. Locke stated that the country between Carlisle and Johnstone Bridge, on the river Annan, embracing the town of Annan, was of the most favourable description. From Johnstone Bridge to Beattock he held to be nearly equally so; and from Beattock to Raecleuch, on the Evan, a distance of about six miles, there would be an inclined plane fitted, as he at present thought, for locomotive engines. At that point, his idea was, that an inclined plane, to be assisted by fixed water power (which could most easily be had) of about two miles in length, would overcome the summit level of the highest land; and the country thence into Lanarkshire would, he trusted, from the information afforded by this meeting, and from the survey about to be made, be found easy. The point in Lanarkshire, from which to start for Edinburgh on the one hand, and Glasgow on the other, seemed to be either Biggar or Lanark. Biggar would be the nearest route towards Edinburgh; and the line for Glasgow would depart not far from Biggar, by Lanark and Hamilton, to Glasgow. The meeting then requested Mr. Locke to proceed forthwith in his survey, and having done so, to present a report on the subject, with a view to an early communication with the great railway companies of London, Birmingham, and Lancashire, the mercantile interests of Edinburgh and Glasgow, and eventually with government.—*Dumfries Courier.*

A HINT.—The reception rooms whence the passengers start upon the Paris and St. Germain railroad at Paris are decorated and fitted up in a style of light and showy elegance, which, though not calculated to bear critical examination, is exactly adapted to its purpose, and presents a most effective *coup d'œil.—Galignani.*

PRESERVATION OF WOOD FROM DECAY.—The wood which is used in the salt mines of Hallein, in Germany, is preserved from decay by being saturated in strong brine. This discovery was made by observing, that the timber which supports the ceiling of the galleries, upon being exposed to the action of the salt earth, became harder and harder, and scarcely ever after liable to decay. From this fact it is supposed that the *bichloride of sodium* is as efficacious in preserving vegetable matter from the destroying energies of the dry-rot, as the *bichloride of mercury*. Certain it is, that the former plan is preferable, to the latter, so far as it is free from the injurious powers which the mercury presents to the workman, when the article which is so prepared is used in manufactories. The former is well worthy of trial, and if found to possess the qualities which it is presumed it contains, its economy and simplicity will place it within the reach of every individual.

AEROSTATION.—An architect at Clifton has just invented an ingenious locomotive apparatus of considerable energy, for propelling a balloon of the largest dimensions through the air, and directing it at will (the one thing needful to perfect the art of aerial navigation); this is effected by a powerful current of air, equal to propelling a superfecies of more than twelve hundred square feet at the rate of fifty or sixty miles per hour! Nothing can be more simple and compact, or manageable than this contrivance, which is made to fit the interior of the car, and the latter is equally well adapted for the sea, as well as the land, in case of accident, and may also readily be converted into a large carriage capable of transporting the whole *materiel* requisite for aeronautical purposes. Application is making for a patent to secure the right of this invention.—*Correspondent of the Bristol Journal.*

STEAM-ENGINES WITHIN THE BOROUGH OF BIRMINGHAM.—By a report made to the Birmingham Philosophical Institution, October, 1836, it appears that 169 steam-engines had been erected from 1780 to that period, of which 17 had been erected in 1834, and 22 in 1835. The total horse power was equal to 2700 horses. Within the same period engines equal to 162 horses' power had become void, or removed. Of those erected and estimated in horse power, 275 were used for grinding flour; 1770 for working metals; 279 for pumping water; 87 for glass grinding; 97 for working wood; 44 for paper-making and glazing; 37 for grinding clay; 61 for grinding colours and chemicals; and 50 for sundry purposes The estimated consumption of coals is 216 tons per day; estimated number of persons employed 4000 males, and 1300 females; and the estimated amount of power hired out, equal to 450 horses. These estimates are confined to engines within the borough, and, of course, do not include the great Soho works of Bolton and Watt. Of the 1770 horse power employed in working metals, it is computed that 162 is used by iron founders, first applied in 1788; 570 in rolling copper, brass, and other metals, first applied in 1790; 150 in drawing wire, first applied in 1808; 201 in iron forges, and wrought iron mills, first applied in 1810; 74 in nail cutting, first applied in 1813; 104 in screw-making, first applied in 1819; and 34 in drawing metal tubes, first applied in 1822.—*Railway Magazine.*

TRIUMPH OF MACHINERY.—At Messrs. D. F. Taylor and Co.'s patent solid-headed pin manufactory, near Stroud, the machinery simultaneously performs the various functions with little noise or effort while converting the rings of wire into pins, without the instrumentality of any manual assistance whatever; for while one combination of the machine is drawing forward, and straightening the wire and cutting it to the required length, another apparatus is forming and smoothing the point, a third compressing and shaping the head, and a fourth detaching and drawing out the pin in its finished state, which falls into a receiver prepared for it; thus forty-five pins per minute are made by machines, while the whole plant is producing the almost incredible number of three millions two hundred thousand pins daily, exceeding nineteen millions weekly throughout the year.

ROTARY STEAM-ENGINE.—We hear that that an engine has been completed on the simplest and most efficient principles, which, in the opinion of competent judges, will accomplish the great desideratum of a uniform and equable action, and on the most economical plan.

WATER POWER.—The discovery of a new application of water power, which is likely to be attended with most important consequences, has been lately made by a tradesman in this town. Like all truly valuable discoveries, it is distinguished alike for simplicity and efficiency. It consists of a cylinder and a piston similar to those employed in a steam-engine. To the cylinder there are two entrance and two discharge pipes, one of each on either side of the stuffing-box of the piston. The same turn of the cock that admits the water into the one part of the cylinder opens the discharge pipe in the other, and thus a vacuum is formed. To work this, advantage is taken of the pressure of the Shaw's Water, the height of the reservoir of which gives it a force of 60lb. to the inch in the lower parts of the town. A short time ago we witnessed an experiment with a cylinder two inches in diameter worked with a jet of water of somewhat less than a quarter of an inch in diameter, and the piston, although loaded with 1¼ cwt., rose and fell sixteen times in the minute. In this case the entrance and discharge pipes were equal in size, and the cylinder was placed in a vertical position. Since then the discoverer has had another model made with the cylinder laid horizontally, and with the discharge pipes nearly three times as large as the entrance ones, and by this means the motion was increased to twenty-six double strokes in the minute.—*Greenock Advertiser.*

EARTHQUAKES.—This year has been remarkable for earthquakes; and at the foot of the Saint Plomb, at Brigue, in the Alps, there seems to be a permanent earthquake, for the movements began on the 22d of February, and have continued ever since, but have considerably diminished in intensity. The earthquake at Lisbon extended as far as Brigue, and caused great destruction there, which adds to the present alarm. Nervous persons are painfully affected by these continued shocks.

RUSSIAN TRADE WITH THE UNITED STATES.—The *Commercial Gazette* of St. Petersburgh contains an article which shows that the commercial crisis in America and England has considerably diminished the export of several of the native productions of Russia. It states that in the first five months of 1836, about 345,000 poods of iron were exported, but this year the quantity amounted to only 292,000. The hemp in 1836 amounted to 271,000; in 1837 to only 96,006. Cloth, in 1836, to 50,614 pieces, and about 1,800,000 archies; but, in 1837, to no more than 33,100 pieces and 300,000 archies. Flax, in 1836, to 22,366 poods, but this year to no more than 82 poods. In the imports there has been but very little difference, and, indeed, they appear to have increased, and more particularly in silks, cotton goods, and Champagne wine, in which last article the importation, in 1836, amounted to 6311 bottles, while this year it has been augmented to 19,401 bottles.

RESULT OF CUTTING DOWN FORESTS.—A M. Devèz Chabriol, in a memoir treating of the effects arising from the extirpation of forests, cites several historical documents, all tending to establish the fact that the temperature of the country is not only lowered by the taking away of the trees, but that streams dry up, and rain ceases to fall. M. Boussingault confirms these by several instances, where lakes have been diminished in consequence of cutting down the neighbouring woods, and the water restored to its former level by suffering the trees to grow again; also where the quantity of water has always remained the same when the woods near it have been left untouched. M. Boussingault states, that in some of the provinces of South America, which are covered with wood, it rains every day; and in others, where the soil is sandy and arid, it never rains; yet these provinces have the same latitude and climate, and the projections and distances of mountains are nearly similar.

CARBONIC ACID GAS.—This gas is destructive of animal life; being very heavy, it accumulates in the bottoms of deep wells, in cellars, caves, &c., which have been shut up for a long period, and fatal accidents occur frequently to persons entering them incautiously; the precaution should always be taken of introducing a lighted candle *before* descending into or entering such places; should the candle be extinguished, or even burn very dimly, it would be dangerous to enter until properly ventilated.

EGYPT.—M. Lefebvre, a civil engineer, has lately performed several mineralogical journies between the Nile and the Red Sea. In these deserts he found an enormous deposit of oriental alabaster, which is now worked by the government. This quarry is seven leagues from Beni-Soueys, and at the top it bears marks of having been formerly worked, but its position does not agree with that ascribed in ancient geography to Alabastron Folis.

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The Mining Journal
AND COMMERCIAL GAZETTE.

SUPPLEMENT---XXIII.

SEVENTH MEETING OF THE BRITISH ASSOCIATION.

The Seventh Meeting of the "British Association for the Advancement of Science," commenced its labours, at Liverpool, on Monday, the 11th of September, concentrating within the town, for the week following, a very large proportion of the talent and intellectual eminence of the country. Without attempting to enumerate the distinguished visitors present at the meeting, we may name the Marquis of Northampton, the President of the preceding year; the Earl of Burlington, the President elect; Sir David Brewster, Sir William Hamilton, Professor Sedgwick, Professor Whewell, Dr. Faraday, Mr. De la Beche, and many other names distinguished by science, and we may also add by rank—while the presence of foreign philosophers was not wanting to complete the interest of the assembly. Among the foreigners present we may name the Baron Dupin, M. Gay Lussac, M. Fresnil, M. Dufrenoy, Professor Moll, and many other foreign members of the Association, who had visited England for the purpose of being present at the meeting.

In numerical strength this meeting, as we had anticipated, considerably exceeded that held last year at Bristol—the number of members at Liverpool amounting to about 1700, while at Bristol it was only 1300, a circumstance of some importance to the funds of the Association, which are chiefly expended in grants to individuals, for the purpose of making experiments and carrying on investigations, involving a cost not always within the means of the parties who are thus engaged. The large accession of members, received from Liverpool and its vicinity, affords a gratifying proof of the estimation in which science is there held, and of this fact, the whole proceedings of the week furnish ample and convincing testimony. The public spirit and liberality with which the Association was received, was highly honourable to the town, and had the effect of greatly facilitating the transaction of business.

The usual preliminary meeting of the General Committee (the legislative body of the Association) was held, as usual, on the Saturday previous to the meeting itself, the Marquis of Northampton, President for the last year, being in the chair. At this meeting the plan of proceedings for the following week was finally arranged and decided upon, and considerable discussion was occasioned by certain propositions involving important deviations from the established practice of the Association. These were—first, an extension of the time of the yearly meeting, in order that some parts of the business, which now press very heavily on the secretaries, might be more leisurely and more satisfactorily performed—and, secondly, some alterations were proposed in the constitution of the General Committee itself, by which the members of the Statistical Society would have been excluded from any *ex officio* seat in the Committee. The former of these propositions was shown by Dr. Granville to involve great inconvenience to a large portion of the members, who, as professional or commercial men, could not be expected, in most cases, to prolong their attendance beyond the week; and some little modification of the present arrangement was finally agreed upon, without extending the time of meeting. The second alteration of the rules was warmly urged by Professor Whewell, but strongly resisted by Colonel Sykes, Dr. Granville, and other members, who asserted the right of Statistics to representation in the General Committee, and it was ultimately agreed that the Presidents for the time being of the Statistical Societies of London and Manchester, should be *ex officio* members of this Committee. The decision will, we believe, be satisfactory to all friends of the Association; nor can we admire the consistency of the learned Professor, who would have excluded from representation in the General Committee the cultivators of a branch of knowledge (if it must not be called a *science*) which had been recognised by the Association as of sufficient importance to form one of the Sections (only seven in number) of which it is constituted. If knowledge is to be valued in the ratio of its utility, and of its advantage to mankind, statistics must certainly hold a distinguished place, since it furnishes the only correct data on which those laws and regulations can be founded, which are so essential to the welfare of society. In arranging and generalising the voluminous materials collected by the more humble labourer, there is, if we mistake not, ample scope for minds of a high and truly philosophical order; but can the devotion of such to the subject be expected, if Statistics is to be thus excluded from the honourable position claimed for other branches of science? We have briefly glanced at these preliminary proceedings, because we attach much importance to them, and we believe that the firmness and good sense of some members of the General Committee were, on this occasion, the means of preventing much injury to the Association, from the adoption of measures tending to *exclusiveness*, and therefore calculated to diminish the great and general benefits arising from the labours and meetings of this important body.

The proceedings of Saturday were appropriately terminated by a grand entertainment given by the Mayor of Liverpool to the members of the Association; and the spirit and liberality evinced throughout the whole meeting by the inhabitants of the town towards their scientific visitors, will ever be remembered with feelings of gratitude—affording, indeed, a complete contrast to the reception which, at the preceding meeting, had been given by Bristol, and which was so little to the credit of that city. It will form no part of our plan to describe the hospitalities which have marked the late meeting of the Association, and which have already been sufficiently noticed by our contemporaries—nor will it be necessary for us to enumerate the various excursions or other incidental features of the meeting. We shall, therefore, proceed to the business of such of the Sections as chiefly interest us, selecting from each those papers which have reference to the object of our publication; and this report will be the more valuable, as we hope to obtain from the authors copies of several of the most important papers of this class, which were read during the meeting.

Selection being therefore our object, we shall not adhere rigidly to the exact order in which the papers were read, or in which the other business of the Association was transacted, but desirous rather to afford a connected view of the whole proceedings, pass on at once to the General Evening Meeting, held on Monday, at which the chair was resigned by the Marquis of Northampton to the Earl of Burlington, the President elect, who was then inaugurated into the duties of office.

At the evening meeting of the Association, held at the Amphitheatre on Monday, the chair was taken by the Marquis of Northampton, who, on resigning office, delivered a short address to the following effect:—

The present was the second meeting of the Association, in which science had been brought to bear on a commercial population; and the town which was thus distinguished, was one in which commerce had most experienced the results of science, for the latter had given to its vehicles on land and to its vessels by sea the velocity of the eagle. The Association held its meeting in Liverpool at a time when men's minds were excited; but the Association was neither conservative nor reforming—neither bound up with Episcopalians nor Dissenters. It taught but one great lesson—a lesson bequeathed to us as a legacy by the author of our faith, "Love one another." The advantages arising from such meetings might be regarded as threefold: first, the improvement, by the stimulus of excitement arising from the aggregation of persons interested in the advancement of human intelligence; secondly, the true increase of reverence for the Deity, by exemplifications of his attributes as a moral Governor of the universe, as well as its Creator; and, thirdly, by its effects in spreading "peace upon earth, good-will towards men." It had been said that philosophers made science an idol, and raised it above the revelation which the Deity had made to his creatures: but he was fully persuaded that science was only the high priest in the great temple of Nature, pointing out both the "how" and the "why" the Great Author of existence was to be worshipped, and receiving revelation to supply deficiencies which science itself pointed out. His Lordship alluded to the diversity of feeling which existed on religious and political subjects, and expressed a hope that science would soften down asperities, melt and solve the harsher feelings, and combine all in endeavours to extend the honour of God and the good of man. They were met on neutral ground, and he was sure no angry feelings would disturb the harmony of investigations intended for the universal benefit. After passing a very high eulogium on his successor, and warmly thanking the Association for the kindness shown him by the members, his Lordship resigned the chair to the Earl of Burlington.

The Earl of Burlington, on taking the chair, acknowledged the high honour conferred on him of being chosen to preside over the aggregated science of the British Empire; but great as was that honour, he felt that the difficulty and the anxiety of such a position were still greater. It was, however, a relief to him, that the Association met in a commercial city, one in which the practical and beneficial results of science in actual life and business had been tested by experience. Though surrounded by many distinguished cultivators of science, men who enjoyed not only British, but European, he might almost say universal fame, he could not avoid lamenting the vacancies in the circle—the absence of those who had given life, vigour, and lustre to previous meetings of the Association. Mr. Vernon Harcourt was, for the first time, absent; he who had watched over the cradle of the Institution, fostered its growth, and most efficiently aided in the development of its strength. The loss of such a man was to be deplored, and it was with grief that his Lordship announced the termination of his official connexion with the Association; but he trusted that Mr. Vernon Harcourt would yet, as a private individual, witness the growing prosperity of an Institution for whose advancement he had so long and so strenuously laboured. The venerable Dr. Dalton was also absent; the infirmities of increasing age had compelled him to abstain from meeting those who delighted to honour the philosopher whose life had been devoted to science, and whose reward had come late: but it was a reward whose justice all acknowledged, and the honours conferred on Dr. Dalton were as gratifying to the public as to himself. His Lordship then observed, that when he looked on those who surrounded him, and saw among them Professor Whewell, a native and an ornament of the county palatine of Lancaster, he could not avoid declaring, that to that gentleman's direction, conversation, and advice, he stood indebted for whatever taste he had for science and scientific pursuits. He then referred to the advantages which general science had derived from the labours of the Association (these will be found fully detailed in Dr. Trail's report), and concluded by saying, that though the dark fields of nature were far more extensive than those which the human mind had examined, traversed, and surveyed, still the powerful minds engaged in investigation, were daily opening untravelled paths for the progress of intelligence, giving to science new stores, and to exertion fresh incentives. His Lordship then called on the secretary to read the report.

Dr. Traill, the Secretary, then read his report—which is thus fully and faithfully given in the pages of our able contemporary, the *Athenæum*:—

The duty of addressing the British Association, on this occasion, was originally confided to one admirably qualified to do justice to the task; and few persons have more cause to lament the circumstances which deprive us of the services of that gentleman, than the individual who now addresses you. To those who know me only as connected with my present domicile, my position at this meeting may appear unwarrantable or presumptuous. I can only plead, that though highly honoured by the office, it certainly was neither expected nor solicited by me: and that, unless twenty-eight years' residence in this place, and the existence of numerous and valued local attachments, may be considered as conferring the privilege, I fear I can advance few claims to be received as one of the secretaries for Liverpool.

The objects and nature of the British Association for the Advancement of Science have been so eloquently handled by my predecessors, that to some members the subject may appear to be exhausted; but, as the Association is necessarily a very fluctuating body—as many have now joined it for the first time—and, as there still seems to be considerable misapprehension in the public mind regarding its objects and utility, a few remarks on the purposes it is intended to accomplish may not be altogether misplaced.

The British Association was undoubtedly suggested by the successful efforts of the philosophers of Germany, within the last few years. The obstacles to the free intercourse between scientific men, in that part of Europe, had always been felt as a great bar to the advance of science. Under such a system, those who, in sequestered regions, had long pursued laborious investigations, had often the mortification to discover that they were following paths trodden by others, or in which they had been completely anticipated by more fortunate inquirers. To obviate such grave inconveniences, and to promote social intercourse among men of science, scattered over wide regions, separated by physical and political obstacles, though connected by one common tongue, were the objects of that great Continental Association; and that these have been, to a considerable extent, realised by the annual assemblages of the illustrious sons of Germany, is generally admitted.

In our more united and highly-favoured land, the facilities of intercourse between its most distant points, the less isolated position of our philosophers undoubtedly render the progress of science less dependent on such general associations of its cultivators than in Germany; yet it has never been doubted, that the personal intercourse of men engaged in similar pursuits is favourable to the progress of philosophical investigations, by the direct assistance derived from the experience and suggestions of others, and by fostering that generous emulation in the search after truth, which imparts a wholesome stimulus to mental exertion, while it tends to smooth the asperities occasionally engendered by controversy, even in the abstract sciences. Men accustomed to meet and act together for one great end, naturally and insensibly imbibe the social spirit—scientific jealousy and personal rivalry are softened by mutual approximations; and individuals composing the Association, like members of the same family, learn to temper the pursuit of personal distinction by an honest exultation in whatever redounds to the honour and celebrity of the body to which they belong. These advantages the British Association shares in common with many other societies; but it possesses characteristics peculiarly its own. It can scarcely reckon a period of infancy—it sprung at once from the conception of its founders, like Pallas from the head of Jove, in the perfection of youthful vigour—secure in the panoply of rectitude of purpose against open or secret hostility. It quickly numbered in its ranks the *élite* of the philosophy of the United Kingdom; and, strengthened by the accession of foreign associates of distinguished reputation, it has extended its views beyond its original horizon, and has attained a colossal magnitude that distinguishes it above every other scientific association in the British empire.

This Institution ought not to be considered as the rival of any of the previously existing philosophical establishments which give lustre to these kingdoms. It, indeed, receives communications on every branch of scientific inquiry, but it professes to publish none of the numerous contributions which have given rise to the interesting and animated discussions in its different sections; a short abstract of these papers is all that it attempts to promulgate; but the distinguishing features of its publications are those invaluable Reports on the progress of science which the Association has confided to some of its members, especially selected for that important duty.

The advantages thus conferred on general science will be best appreciated by persons whose studies are directed to any of the subjects discussed in the Reports, and who have once felt the want of an accurate analysis of what had been recently added to our previous stock of knowledge; but it would be impossible to calculate in how many instances those abstracts of precise and useful information have saved the time, and abridged the labour, of the retired student, in tracks already explored by other philosophers. Another peculiarity in the publications of the Association consists in the circulation of *desiderata* in different branches of science. The attention of their cultivators, thus drawn to the principal deficiencies in each, has already filled up various chasms in the paths of intellectual exertion, and stimulated to inquiries that cannot fail to lead to important results.

It soon became apparent that the British Association must exercise a powerful influence on the general diffusion of science, and could undertake, or materially promote, investigations to which individual research, and unaided exertion, are utterly inadequate. Its annual migrations, and the comparative ease of admission into its ranks, have unquestionably increased the taste for scientific disquisition; and, although it would be absurd to suppose that all who seek for enrolment in the Association are destined to extend the boundaries of science, who can believe that familiarizing large masses of the community with such investigations, and exhibiting how the highest branches of philosophy may be made available to the purposes of life, will fail to promote the avowed purpose of our meetings? Who will venture to deny, that the contemplation of the galaxy of illustrious men, mustered on occasions similar to the present, has often proved the first impulse to the secret aspirant after honourable distinction—has afforded the *Promethean spark*, that kindled the sacred flame in the breast of slumbering genius?

The Association has not failed to use its influence in stimulating our rulers to aid the progress of science. At its instigation, the British government has taken up the task of the reduction of the enormous mass of observations on the heavenly bodies, accumulated since 1750, at the Greenwich Observatory—which, though collected at a great expense to the nation, and by the exertion of consummate skill in the observers—which, though pronounced by the highest authorities in Europe to be of the utmost moment to the future progress of astronomy—have been permitted to remain a rich, but unexplored, mine of facts. The voice of our petition has been heard—the work has been auspiciously begun—and 500*l.* have been assigned by the Treasury for the commencement of this great national work.

The subject of the Tides, so strangely neglected in this great maritime country, from the period of the promulgation of the Newtonian Theory to our own times, has engaged the attention of the Association from its commencement. The advances which have recently been made on this subject, and which have greatly altered the aspect of that branch of science, had chiefly for their original basis the very valuable tide observations made in this port, many years ago, by Mr. Hutchinson, a dock-master, embracing an interval of above thirty years. The originals are preserved in the Lyceum Library of Liverpool; and, by the liberality of the proprietors, have been confided to the hands of Mr. Lubbock, under whose direction the discussion of them, ordered by the Association, has thrown a new light on the laws of Tidal phenomena.

Since that time, the earnest representations of a distinguished associate, whom this country claims as a native, have given rise to a most important set of observations on the tides. Mr. Whewell, by personal application to the chief of the coast-guard service, and solicitation to the Admiralty, has procured the completion of a continuous series of observations, at upwards of 500 stations, along the coasts of Great Britain and Ireland. They were continued for a fortnight in June, 1834, and again in June, 1835, when they were extended from the mouths of the Mississippi to the northern extremity of Europe. These observations have been *discussed* at the expense of the Admiralty; but, as I shall presently mention, the Association has voted a large sum to be applied by Mr. Lubbock to the same subject.

These discussions have, within the last few years, led to very curious results: for instance, to the fact of *the rise of the mean level of the tides, in proportion to the fall of the barometer, and the existence of a diurnal tide—i. e.* the difference between the morning and evening tides of the same day. The diurnal tide, it may be interesting for the inhabitants of Liverpool to know, was first marked in the tide tables constructed by a young ingenious townsman, Mr. Bywater, jun., who has, unfortunately for science, died since the last meeting of the Association.

The importance of the subject, and the success already obtained, have encouraged the Association to direct the discussion of the Tidal observations recorded at the port of Bristol, and at the London Docks; and to supply the means of defraying the necessary expense.

The influence of researches on tidal waters to navigation and to commerce are too obvious to require illustration; but perhaps it may not be unsuitable, in this place, to refer to the deductions of our eminent associate, Captain Denham, on the capability of the Mersey "to command a navigable avenue to the ocean, so long as its guardians preserve the high-water boundaries from artificial contraction." It may also be stated, that in our Transactions, this gentleman has recorded his most important general inference (drawn from a connected series of observations on the tides, which the liberality of the Dock Trustees of Liverpool enabled him to carry on)—*that there is one invariable mean height, common to neap and spring tides*—THE HALF TIDE MARK—a point from which engineers, geologists, and navigators will henceforward commence their calculations, and adjust their standards of comparison.

The Association made application soon after the meeting at Edinburgh for the resumption of the Trigonometrical Survey of Scotland; a work imperiously demanded by the imperfect state of our best maps and charts of that part of the island, either for the purposes of geology or navigation. It is needless to give further proof, than that parts of several of the large islands at the mouth of the Clyde are laid down several miles out of their true position. The magnificent scale on which the survey of Ireland is now carrying on, emboldened various scientific societies of Scotland this year to memorialize the government on the subject. I am happy to add, that the applications have been successful, and the triangulation of Scotland will recommence early in 1838.

The British Association may also boast, that at its instigation our illustrious associate, Arago, moved the Bureau des Longitudes to solicit from the French government the publication of the series of observations on the tides at Brest, and a reduction of the astronomical observations made at the Ecole Militaire. The Brest observations have been printed, and a copy of the valuable documents put in the hands of one well able to appreciate them.

At the Dublin meeting, a committee was appointed for representing to our own government two objects important to science; which can only be accomplished in a satisfactory manner by the rulers of a powerful nation, or by an union of governments in the cause of philosophy. The first related to the establishment of Magnetical and Meteorological Observatories, in different parts of the earth, furnished with proper instruments, and in which the observations should be conducted on acknowledged and uniform principles. The extent, and the variety of climate of the British possessions, indicate them as favourable points for such establishments, which have already been commenced in France and its dependencies, and may hereafter, by the co-operation of the several governments of Europe, and of our transatlantic brethren, be extended over a large portion of the civilized world. The second suggestion was the importance of an Antarctic Expedition, for prosecuting discoveries and observations in Geography, Hydrography, Natural History, and, above all, Magnetism, with a view to determine the positive southern magnetic pole or poles, and the direction and intensity of the magnetic force in antarctic regions. The East India Company was likewise to be requested to favour the same objects, especially at their establishment at Madras.

The general committee some time ago made application to the authorities, both in France and this country, respecting some mode of instituting a reciprocal protection to literary property. Might I venture here to allude to a recommendation which I hope the Association will not fail to leave in Liverpool, for the promotion of a scientific object of immense consequence to

this port—the establishment of an observatory in or near Liverpool. The adoption of such suggestions, while conferring an incalculable benefit on science, would rear a proud, unperishable, and bloodless monument to national greatness.

These statements might be a sufficient answer to a question, sometimes put in tones of captious sarcasm,—What has the Association directly contributed to the progress of useful knowledge? Without again appealing to the very admirable reports on the progress of science published in our Transactions; without again claiming merit for the suggestions and efforts already noticed,—I should fearlessly answer such cavillers, by an appeal to the value and number of the communications, which have occupied the different Sections, at each annual meeting, and which contain the application of pure science to important questions in Physics, or of experimental investigation to numerous branches of knowledge. I would point to the valuable researches which have been undertaken and completed at the request of the Association, among which it may be permitted to indicate the following memoirs:—The comparison of the standards of Linear Measure, made by the late Mr. Troughton, for the town of Aberdeen, and the Astronomical Society of London, which were confided to Mr. Baily—a comparison of much consequence, as the *standard yard*, by the same eminent artist, was lost in the fire which consumed both Houses of Parliament; On the Investigation of the Impact upon Beams, when struck by bodies of different weight, hardness, and elasticity, by Mr. Hodgkinson; On the Direction and Intensity of the Magnetic Force in England, Ireland, and Scotland, by Professor Lloyd, Major Sabine, and Captain James Ross; On the influence of Height above the Sea on Magnetic Intensity, by Professor Forbes—from which it appears that the horizontal intensity diminishes $\frac{1}{1000}$ of the whole, for every 3000 feet of vertical ascent; On the quantity of Rain falling at different heights above the surface of the Ground, made at York, by Professor Phillips, and Mr. Gray; On the determination of the mass of the planet Jupiter, by the Astronomer Royal; On the Horary Variations of the Barometer, Thermometer, Hygrometer, and Whewell's Anemometer, by Mr. Snow Harris—part of which has already appeared, and of which the sequel will be laid before this annual meeting; On the Duty performed by Cornish Steam Engines, by Mr. Enys; On the Ratio of the Resistance of Fluids to the Velocity of Waves, by Mr. Russell and Mr. Robison—of which we expect to receive an account on this occasion.

We may also be permitted here to allude to some highly-interesting investigations, still in progress, under the auspices of the Association, such as—Observations on the Temperature of Springs and Deep Mines, by Instruments procured and verified by the Meteorological Council, which are already placed in various districts of Great Britain and Ireland, and also in Peru, under the direction of our scientific associate, Mr. Pentland, and from which results most interesting to Geology are anticipated; On the Temperature of the strata at different depths near Edinburgh, by Professor Forbes, for ascertaining the rate of the transmission of Solar Heat downwards; A continuation of Mr. Vernon Harcourt's experiments on the effects of long-continued Heat on Rocks and other bodies; Experimental Investigations into the Fabrication of Glass, by the same gentleman and Dr. Faraday; A Systematic Catalogue of all the Organized Fossils of the British Islands, by Professor Phillips; An Experimental Determination of the Strength and other Mechanical Properties of Iron obtained by the Hot and Cold-Blasts, undertaken by Messrs. Hodgkinson and Fairburn; Analysis of Iron in the different stages of its manufacture, and an Extension of the Tables of Chemical Constants, by Professor Johnston; Statistical Returns of the State of Education in our great towns; An Examination of the Statistical documents preserved in the India House, by Professor Jones; besides the discussion of numerous very interesting contested points in Natural History and in Medicine.

These are satisfactory evidences of the activity of the Association; but it has not scrupled also to afford pecuniary assistance, when such aid appeared requisite to ensure success. It is true, that the moderate sum, payable on admission into the society, seems more suited to the finances of the majority of philosophers, than to the support of extensive enterprises; yet the numbers, annually, desirous of admission, supply funds, adequate to important undertakings; and the power thus given to the general committee is acknowledged to have been exercised with a sound discretion.

Without descending to minute particulars, it may be well to state some of the appropriations for various scientific inquiries.

The application to the French government already noticed, was accompanied by a vote of the general committee of the Association to appropriate 500*l.* for a duplicate reduction of the Astronomical Observations, with a view to secure the utmost accuracy in these important computations. This offer proves the value attached by the Association to whatever can improve Astronomy, and the zeal which carries its scientific views even beyond the limits of the British Empire. This sum is still devoted to the reduction of Astronomical Observations. 70*l.* have been devoted to the determination of a constant numerical expressions for Lunar Notation, as deduced from the observations made with the Greenwich mural circle. 250*l.* have been appropriated for the Discussion of the Tides; besides 150*l.* voted last year for the Discussion of the Observations made on the Tides at Bristol. 100*l.* were set apart for meteorological instruments, and experiments on subterranean temperature,—the last a problem of the highest interest to Geology, as involving the question whether or not there be a general source of terrestrial heat, independent of solar influence. 500*l.* have been voted for ascertaining the permanence or fluctuation in the relative level of the land and of the ocean, on the coasts of the British Isles. This subject affords matter for the highest speculations in Geology; but it is doubly interesting to a maritime people, as affecting the permanence of our river navigation, and of our naval stations. 210*l.* were given to enable M. Agassiz to include the fossil fishes of our islands among his interesting Researches on Fossil Ichthyology; a publication which forms a new era in this department of Geology. 100*l.* have been assigned for Investigations on the Form of Waves, and the mode of their production. 150*l.* for the experiments on Vitrification, and the improvement of the manufacture of Glass. 80*l.* for experiments on Lenses of Rock Salt; a subject of much interest to Optics. 50*l.* for determining the specific gravity of Gases. 60*l.* for an experimental inquiry into the strength of Iron. 50*l.* for ascertaining the Duty of Steam Engines. 50*l.* for an inquiry into the Origin of Peat Mosses. 250*l.* for conducting various Physiological Researches. 150*l.* have likewise been voted for investigating the Statistics of Education in our large towns. While on this subject, I must not omit to state, that the active Statistical Societies of London and Manchester trace their origin to this Association; and that the laborious investigations of Colonel Sykes, on the Statistics of India, founded on materials chiefly collected by himself, and undertaken at the request of the Association, are now happily brought to a close, and will be presented to the Association.

These appropriations are exclusive of several minor sums devoted to the encouragement of investigations into various branches of Physics, Chemistry, and Natural History; making an aggregate of upwards of 2659*l.* already set apart from the funds of the Association, for scientific objects—a larger sum than has been appropriated, in so short a period, by any other society, to purposes purely scientific.

While stating these facts, we ought not to conceal a circumstance, creditable to the disinterested zeal for the cause of science elicited by these grants. Though the votes have been liberal, this has never induced inconsiderate expenditure. In many instances, far less than the sums appropriated have been actually expended; and in various instances, the individuals intrusted with the funds have refused to draw on the Association, when their own labour could save its finances.

It has been usually considered a part of the duty of the Local Secretary, to give a short account of the reports which are just published.

The first in the volume is the masterly report "On Mineral and Thermal Waters," by Dr. Daubeny. After glancing at the nature of atmospheric water, the author has pointed out the connexion of the foreign ingredients, detected in the atmosphere, with the production of meteoric stones, the formation of nitric acid under certain circumstances, and the presence of the organic principle, found in air, even when collected on great elevations, to which the name of Pyrrhine has been given. He considers the existence of the elements of meteoric stones in the atmosphere as doubtful. The nitric acid may sometimes arise from the effects of electric explosions on its oxygen and nitrogen; at other times this union is seemingly produced by causes not yet ascertained. The researches of the celebrated Ehrenberg have shown, that pyrrhine probably owes its origin to the ova of polygastric *infusoria*, raised by evaporation and by atmospheric currents induced by changes of temperature. In considering the ocean, the author directs particular attention to its gaseous contents; as confirming or invalidating the opinion of Arago, that oxygen predominates in all waters, even to considerable depths. This law is well-known to hold good in the more superficial portions of the ocean, and seems intended to support the respiration of aquatic animals; but the preponderance of oxygen at great depths, cannot yet be considered as absolutely determined, on account of the imperfection of the modes of obtaining unmixed water from such points. The water of springs is more especially the object of Dr. Daubeny's Report.

In considering the saline contents of mineral springs, he gives some ingenious speculations on the origin of these salts; especially of the carbonate of soda, of the sulphates, and of boracic acid. The common salt he derives from the same source as the saltness of the sea; and he considers rock-salt as a deposition from the waters of the ocean; a view confirmed by the presence in saline deposits, of iodine and bromine—elements first detected in marine productions. Dr. Daubeny ascribes the absence of these two bodies in the lowest and purest bed of the Cheshire rock salt, while they abound in the upper salliferous beds, as proofs that rock salt was deposited from a saturated solution. The salts of iodine and bromine, as well as the earthy muriates, from their greater solubility, would remain longer in solution, and thus be mingled with the more hasty mechanical deposits from the waters. The brine springs of Droitwich, which are found to contain neither iodine nor bromine, he also considers as derived from a salt deposited from a saturated solution.

The silicious earth, so often detected in thermal springs, he conceives to be dissolved by alkaline matter, aided by a high temperature. Both alkali and silica may be afforded by felspathic rocks: and Dr. Daubeny conjectures, that silica may be more soluble in hot water at the moment of its separation from its combinations in the rock, or ere it has its aggregation increased by assuming the crystalline texture. He states, that it may be interesting to try, whether hot water has a stronger action on such bodies as opal, in which the molecules do not seem to have a true crystalline arrangement, than on quartz. Since I came this time to Liverpool, I subjected a fragment of wood opal for fourteen days to a temperature estimated about 280 degrees Fahrenheit, in the boiler of a fixed steam-engine; but it had neither lost nor gained the smallest weight in that time.

The author combats the opinion of Anglada on the origin of the organic matter termed *Glairine*, now found to be a very common ingredient of thermal springs. This substance Anglada supposes, with little probability, to be derived from the interior of the earth; while the observations of our author on this substance, as collected from above fifty springs, especially from the thermal sources of the Pyrenees, show, that *Glairine* is probably derived from the decomposition of organic bodies, such as *confervæ* and infusory animalcules.

The author's speculations on the source of the heat of thermal springs, partake of his views on the origin of volcanoes; namely, that it depends on the penetration of water, through fissures in the external crust of the globe, to the regions where he conceives the elements of earthy and alkaline bodies to exist; that the intense heat, generated during the oxidation of these elements, converts a portion of the water into steam, which, under compression, obtains a high temperature, acts on various earthy bodies, and communicates its heat to subterranean waters which issue in thermal springs. This view he supports by numerous instances observed by geologists; especially by Professor Forbes in the Pyrenees, where thermal waters gush out in the vicinity of disruptions, or upheavings of strata by igniguous rocks. The author believes that, unless in countries agitated by volcanic action, the temperature of thermal springs is subject to little variation; and, that where the contrary has been alleged, it may generally be ascribed to the imperfection of the thermometers employed.

The temperature of copious springs has generally been observed to vary little, and is about the mean temperature of the country where they occur. Thus the magnificent fountain at Vaucluse, has the mean temperature of that part of France, and scarcely ever varies one degree of Reaumur. It is, however, worthy of remark, that I found the temperature of St. Winifred's Well, the largest spring in Britain, by different observations during twenty years, to experience variations of more than four degrees of Fah., always to have a temperature several degrees above the mean of Flintshire, and at all seasons superior to that of another very large spring, Fynnon asaa, about five miles distant. The variations may perhaps arise from surface water, directly finding its way into the Holywell spring; but its constant superior temperature may be accounted for, on Dr. Daubeny's principle, from the disturbances in the strata produced by the numerous mineral veins in the adjacent Halkim Mountains.

The second report is "On the Direction and Intensity of Terrestrial Magnetism in Scotland," by Major Sabine.

The experiments were made at numerous stations, both by the statical method of Professor Lloyd, in which the dip and intensity are ascertained by the same instrument, and by Hansteen's method of measuring intensity by the number of horizontal vibrations in a given time. It is interesting to know, that the intensities estimated by both methods nearly correspond; and that we therefore may place confidence in either mode of observing, when allowance is made for changes in the force of magnetism in the needles employed. Major Sabine experienced, on several occasions, what has been remarked by other observers, that magnetical experiments are liable to be affected by the vicinity of Trap rocks. This was particularly noticed by him at Oban and Loch Scavig, so as to render his observations at the latter of no utility for his calculations. Two of the most familiar examples of this quality of igniguenous rocks are afforded by the powerful effect of a column of the Giant's Causeway, as mentioned by Professor Lloyd; and by the strong polarity of the basaltic cap of Arthur's Seat, near Edinburgh, which is capable, in more positions than one, of causing complete inversion of poles of the pocket compass. These instances show how carefully the vicinity of considerable masses of Trap rocks should hereafter be avoided, in all delicate experiments on magnetic dip and intensity: for the errors they occasion may be more considerable than the effect of a ship's local attraction on azimuths, and are far less easily compensated.

Major Sabine has considered it best to give no other designation, on his chart, to the Isodynamic lines in Scotland, than what expresses their relation to each other, until we have more fully investigated their relation to magnetic intensity in England. The differences between the deductions, in regard to the isodynamic lines in Scotland and in Ireland, are very considerable, and apparently too great to be due to any difference in the lines themselves: but observations are still too few to afford accurate results.

In a former volume of our Transactions, appeared a valuable report on North American Geology: in that just announced is an excellent essay on the Zoology of that portion of the globe, by Dr. Richardson, the intrepid friend and companion of Sir John Franklin, in their hazardous exploratory expeditions to the shores of the Arctic Ocean. After some general remarks on the climate of North America, he presents us with an extensive Table of Mean Temperatures, calculated for periods of six and three months throughout the year, for the hottest and the coldest months, and for the months with a mean temperature above fifty-two degrees Fah., taken at forty-four different stations, and collected from his own and Franklin's observations, combined with those of Humboldt, Ross, Parry, and Scoresby. The results are very important; and show, in a striking manner, the very erroneous deductions on the mean temperature of any place, if investigated by Mayer's formulæ, especially in very low or very high latitudes.

The geographical position of Mexico constitutes that point in which the Faunæ of the northern and southern regions meet; and, hence, it is the place in which the general laws, regulating the distribution of animals, can be most satisfactorily studied. There the wolf of a northern climate is seen with the monkey of tropical regions; the bunting and the titmouse nestle near the parrot and the trogon; the phalarope of the north seeks its food on the same beach as the jacana and the boatbill of Brazil.

Dr. Richardson states, that, though colonization has, in America, restricted the range and modified the migrations of wild animals, we have no evidence that a single species has been there lost within the records of history. The quadrumana, or monkeys, of America are also peculiar to that continent. None of them have what may be called a perfect hand, with the thumb opposed to the fingers. Their thumbs are small, sometimes only rudimentary, or even wholly wanting. Not a single ape—not one true baboon is to be found among them; but many are furnished with prehensile tails, admirably adapted for animals moving among thick forests, and almost as serviceable for grasping as the proboscis of the elephant.

Almost all the Mammifera, considered as common to the New and Old Worlds, belong to the order of Carnivora. Yet, it is by no means improbable that a minute examination of species, now considered as the same, may detect specific differences among them. I would particularly recommend attention to the skulls of animals. My late ingenious young friend, Robert Jameson, of Edinburgh, had acquired great tact in discriminating the Carnivora, in particular by the form and position of the sutures uniting the bones of the face, which differ much in each species. It is believed by many naturalists, that the proportions of the skulls of Indian birds, in other respects similar to our own, as compared to their bodies, differ from those of Europe. Similar differences may occur in other parts of the skeletons of quadrupeds, which have escaped the superficial examiner, yet sufficient to constitute specific characters. This would be particularly valuable in determining the species of weasels and amphibious Carnivora, which, at present, are very perplexing to the naturalist.

All the existing *marsupial* animals are confined to America, Australia, and some other South Sea islands: yet, at one period, animals of this order must have been very generally distributed over the earth, as their bones occur everywhere in a fossil state, and are formed in the oldest deposits of mammiferous remains.

The number of Rodentia in North America is great, and all seem to be peculiar to the New World: of the Edentata, one only is found in North America. Two or three species occur in Africa and India—all the rest are South American. It is singular that of the existing Pachydermata, two species only are considered as indigenous to America—the tapir and the peccary; and of these, the last only is found in North America. Yet no region can boast of more numerous, or more gigantic species of fossil animals of this order—as elephants and mastodons—and, what is remarkable, though the present race of horses is acknowledged to be not indigenous, fossil bones of the horse were found on the north-west coast by Captain Beechy, mingled with those of elephants. Of the Ruminantia, two only seem to be common to the Old and New World—the reindeer and the elk—unless we admit that the argali of Siberia is the same as the sheep of the Rocky Mountains.

The Cetacea, as might be expected from their mode of life, may be considered as common to both worlds. The *Rytina Borealis* and *Manatus Americanus* are formed in North America, but not in the seas of Europe. Temminck estimates that we have 930 well ascertained, and 140 doubtful species of Mammifera; of these 207 are in the New World, and 169 in North America. The birds of North America are most numerous, and have been illustrated by the successive labours of Pennant, Wilson, the Prince of Musignano; but, above all, in the Fauna Boreali-Americana of Richardson and Swainson, and the superb work of Audubon. The similarity between the birds of Europe and North America is marked by one-third of the species being common to both Faunæ. These are chiefly to be found among the Grallatores and Natatores, two-thirds of which orders are common to both: of the order Rapaces, several are common to both continents. The Insessores are very numerous, and a great number are peculiar to America. The Rosores in all countries are little disposed to migrate; and almost all of this order, found in America, are peculiar to it, with the exception of some pigeons and a few Arctic grouse.

The Reptilia of North America are exceedingly numerous. All, with the exception of some sea-turtle, are distinct from those of the Old World. Two genera equally fitted to live in water and in air, as possessing both gills and lungs, and represented by the *Siren lacertina* and *Meopoma gigantea*, which abound in North America, have only one analogous animal in the Old World, the *Proteus anguineus* of the lakes and caves of Carniola.

Many species of the fishes of the American seas are found elsewhere; but the only fresh-water fish, common to both worlds, appears to be the pike. Yet, it is singular, that it does not occur in the waters to the west of the Rocky Mountains, although there the two continents are more approximated. Some of the family of the Salmonidæ and Clupiadæ, which visit America, have much resemblance to those of Europe.

This report is an excellent specimen of the method of comparing the Faunæ of distant regions, and presents a model of a philosophical disquisition on the geographical distribution of animals.

The Association has, at different times, received three able reports from Professor Challis, of Cambridge, on the Mathematical Theory of Fluids. In the first he showed how the application of mathematical analysis to investigating the properties of an imaginary fluid, supposed incompressible, or so compressible, that the density should always be proportional to the pressure it sustains, admits of comparison with facts observed in the equilibrium and motion of water, or in the existing mechanical qualities of air. In the second, the author considered the modifications which these theories had, in later times, sustained by the introduction of certain molecular hypotheses on the constitution of matter, and how a comparison of the consequences of these hypothetical speculations, with experimental results, served to establish the basis of the mathematical reasoning, and to make known properties and conditions of bodies not cognizable by our senses.

The present report treats of several very important points in the Mechanical Theory of the Atmosphere. He considers Mr. Atkinson's (Trans. of Royal Astron. Soc. vol. ii.) attempt to ascertain the law of variation of temperature, at different heights in the atmosphere, as requiring, for its establishment, a more extensive series of observations, over a greater portion of the earth's surface than we now possess.

The difference between the velocity of sound, as determined by experiment, and Newton's deduction from Boyle's and Mariotte's law of elastic fluids, amounting to one-sixth of the whole, has given rise to many attempts to solve the problem, especially by Euler, Lagrange, and Laplace. The latter gave the true solution of the discrepancy—namely, that it arises from the evolution of heat, and its absorption, which accompany every sudden compression or expansion of air. The application of analysis, to afford a formula of correction, was first attempted by Biot and Laplace, and more lately by Ivory; but when we compare the theoretic deduction with the best experiments on the propagation of sound, by Moll and Van Beck, at Utrecht, by Goldingham, at Madras, and Parry and Foster in the Arctic regions, the slight discrepancies between experiment and calculation are more to be attributed to some imperfection in our formula than to error in experiments, which in their results agree so nearly, though made under very different circumstances.

Under the head of Theories of Elastic Fluids, the author has introduced some valuable remarks upon the Memoirs of Poisson, on the equilibrium and motion of elastic bodies, on the equilibrium of fluids, and the pressure of fluids in motion; and also on Laplace's Theory of Capillary Attraction; for which I must refer to the Report.

We have next two Reports on the Comparative Botany of Scotland and Ireland, by Mr. Mackay and Professor Graham, of Edinburgh. The first indicates the more remarkable plants that characterize the neighbourhood of Dublin and Edinburgh. In the second, Mr. Mackay points out the effect of climate on the Flora of Ireland. Ireland, it is true, has fewer species of plants than Great Britain, and possesses fewer alpine plants than Scotland. The position and moister climate, however, put it in possession of many plants not found in Great Britain, but of species occurring in Spain and Portugal, among which may be noticed *Erica Mediterranea*, *Erica Mackiana*, *Pinguicola grandiflora*, *Arbutus unedo*, *Menziesia polyfolia*.

The Reports from the London and Dublin sub-committees, on the Motions and Sounds of the Heart, in this and the last volume, will interest the physiologist and the physician. Ever since the application of the stethoscope, by Laennec, to the investigation of pectoral diseases, the sounds of the heart have been anxiously explored—its normal sounds studied, and its abnormal *bruits* eagerly inquired into, as important diognostics of health and disease. The causes of those have been matter of dispute; the investigation was recommended by the Association; and a sum appropriated for the expense of experiments on the subject. The Reports are the results of the labours of two sub-committees, who agree on the principal points, viz., that the first sound is produced during the systole, or contraction of the ventricles; and that the second sound is produced by the sudden check, which the action of the semilunar valves gives to the current of blood impelled against them, by the elasticity of the arteries. In the second Dublin Reports, the abnormal sounds are illustrated by some ingeniously-devised experiments; but both sub-committees admit, that the motions and sounds of the heart require further investigation.

The Dublin Committee, on the Pathology of the Brain and Nerves, express their opinion, that to arrive at any accurate conclusions on so extensive and difficult a subject, a very large number of cases must be first submitted to examination, their symptoms during life accurately noted, and minute examinations instituted after death. One hundred and seventy-eight males and two hundred and ninety-four females, labouring under nervous affections, are in the Dublin House of Industry and Hospitals, of whom forty-one have already been accurately examined, for the object just alluded to.

The results of the Discussion of the Observations on the Tides, obtained by means of the grants of the Association, have been reported by Mr. Lubbock.

Mr. Dessiou was employed to discuss the Tides observed at Liverpool, so as to ascertain the diurnal inequalities in their height, and also to classify the errors of prediction for a year in Liverpool and at the London Docks. The result is, that Daussy's deduction from the observations at Brest is confirmed, viz., that the height of high water is diminished when the barometer is high, and increased when it is low.

The various discussions of nineteen years of observations at the London Docks, amounting to 13,370, for the purpose of deducing the diurnal irregularities, and examining the effects of the moon's transit immediately preceding high water, and those of the two previous days, lead to the conclusion, that Bernouilli's theory of Equilibrium "satisfies the phenomena, nearly, if not quite, within the limits of errors of the observations," and that it leaves very little to be otherwise accounted for.

A short statement is made by Professor Powell, of Oxford, on the Determination of Refractive indices for the definite rays in the Solar Spectrum, from direct observation. The investigations recommended in the third Report of the Association, have been commenced by Professor Powell, who continues his observations.

Mr. Hodgkinson reported from the London Physiological Committee, that their investigations have not established the views of Lippi, respecting the communications of the absorbents with the veins; but they do not warrant a rejection of his observations, nor amount to any proof that the thoracic duct is the sole medium of communication between the lacteals and the veins. Direct communications between absorbents and veins have been observed by the reporter: but he is disposed to consider these as deviations from the normal structure.

A short report on the best methods of ascertaining Subterranean Temperatures, and the proper form for Registers of such observations, is published by a committee appointed for the purpose.

The last Report in the volume is the very profound Examination, by Sir William Hamilton, of the Validity of Mr. Jerrard's proposed method of *Transforming and Resolving the higher degrees of Equations*, as contained in his "Mathematical Researches." Mr. Jerrard's method may be characterized as consisting in rendering the problem indeterminate, and in employing this very property to decompose certain of the conditions into others, for the purpose of avoiding that elevation of degree, that would otherwise be the consequence of the elimination. The ingenuity of the principle, and the talent displayed in the researches, are freely admitted by Sir William, who contends that the process is valid, as a general and unexpected transformation of equations of elevated degrees, though it fails as a method of resolving them; and who thus sums up the result of his investigations on the subject. "This method of *decomposition* has, however, conducted, in the hands of Mr. Jerrard, to *transformations* of equations, which must be considered as discoveries in algebra; and to the solution of an extensive class of problems in the analysis of *indeterminates*, which had not before been resolved; the *notation*, also, of *symmetric functions*, which has been employed by that mathematician, in his published researches on these subjects, is one of great beauty and power."

On the very valuable matter contained in the proceedings of the Sections, time will not permit me to enter, and I must refer you to the volume just published.

In conclusion, allow me, in the name of my respected collegues and of our Liverpool associates, to offer a sincere and hearty welcome to the distinguished strangers, whose presence confers additional interest to this meeting; and secondly, to congratulate the town of Liverpool on the exertions it has made, worthily to receive an Association, which, aiming at the diffusion of a general taste for scientific investigations, and their application to the

improvement of society, seems calculated to perform an important part in the future destinies of our country—which, as co-operating with all other scientific bodies, and the rival of none, but including in its lists representatives from each—which, distinguished by the freedom of its discussions, the liberality of its assistance, and the importance of its recommendations, has been happily characterized, by an eloquent secretary of a former year, as a *Fourth Estate in the Realm*, and aptly designated HER MAJESTY'S PARLIAMENT OF SCIENCE.

Dr. Traill having concluded the above report, the usual financial statements were given by the Treasurer for the year ending 31st July. From this report we collected that—

The balance brought forward on the account of the Association, was 607*l.* 13s. 3d.; received in the year compensation from 209 life members, 985*l.*; subscriptions for 1836 of 1121 annual members, 1121*l.*; for the year 1837, 25*l.*; for the year 1835, 24*l.*—making the amount of subscriptions for the last year, 2125*l.* They had received dividends on 4735*l.* stock, 135*l.*; for the sale of different volumes of the Association, 415*l.* 14s. 11d.—making the amount received on account of the Association, 3313*l.* 8s. 2d. The expenditure consisted:—Expenses various, 265*l.*; for the local treasurer's sundry disbursements, 135*l.* 14s.; purchase of 1000*l.* bonds 3 per cent., 800*l.*; salary of assistant secretary and accountant, 234*l.*; grants for scientific researches to the discussion committee on temperature, 97*l.* 10s.; for the present year, 186*l.* 11s.; tidal observations at Bristol, 150*l.*; for researches in lunar observations, 70*l.*; for the committee for meteorological observations, 93*l.* 10s.; researches on the form of waves, 100*l.* 12s.; experiments on the sounds and motions of the heart, 8*l.* 4s. 6d.; researches with respect to atmospherical air, 11*l.* 18s. 6d.; for barometrical observations, 50*l.*; thermometrical observations, 150*l.*; chemical experiments, 24*l.*; making various payments, 372*l.* 12s. 4d.; for printing reports of fourth volume, 536*l.* 11s.; abridging reports, 52*l.*; sundry printing and advertising, 41*l.*; balance in the hands of the treasurer, 248*l.*—making up 3318*l.* 8s. 2d., which, altogether, would leave the present property of the Society previous to the meeting at Liverpool, at about 5000*l.* He begged to mention, that, at the close of the meeting at Bristol, the number of tickets issued, was 1305. When he left the Townhall that day at twelve o'clock, the number then issued was 1412. That number seemed likely to be largely increased, and the funds of the Society seemed likely to receive here a large addition.

The proceedings and transactions of the Association, during the past year, are ably summed up in the long and elaborate Report of the Secretary, which we have now given, and which forms an admirable summary of its labours for that period. Previously to confining ourselves to the transactions of those Sections which fall more particularly within our province, as embracing subjects connected with Chemistry, Mineralogy, Geology, Mechanics, &c., we insert the following list of the Sections, with the names of the gentlemen composing the Committees of each, so as to give a general idea of the scope and constitution of the Association at its late meeting:—

SECTION A.—MATHEMATICS AND PHYSICS.

President.—Sir David Brewster.
Vice-Presidents.—Mr. Lubbock, Mr. Baily, Mr. Peacock.
Secretaries.—Rev. Professor Powell, Professor Stevelly, Mr. W. S. Harris.
Committee.—Rev. Dr. Robinson, Sir W. Hamilton, Professor Christie, Rev. W. Whewell, Professor Lloyd, Professor De la Rive, Professor Plateau, Professor Henry, Dr. Faraday, F.R.S., Professor Wheatstone, Dr. Ritchie, Major Sabine, Rev. Dr. Hincks, Mr. Russell, Professor Moll, Captain Ross, R. W. Fox, Professor M'Cullagh, Professor Challis.

SECTION B.—CHEMISTRY.

President.—Dr. Faraday, F.R.S.
Vice-Presidents.—Professor Daniell, Professor Graham, Dr. Apjohn.
Secretaries.—Professor Johnston, Dr. Reynolds, Professor Miller.
Committee.—Monsieur De la Rive, Dr. Thomas Thompson, M. Gay Lussac, M. Liebig, Dr. Yellowly, Professor Cumming, Mr. Richard Phillips, Mr. W. Herepath, Professor Edmund Davy, Dr. Andrews, Professor Clark, Mr. W. Lucas, Mr. H. H. Watson, Dr. Kane, Mr. Mackintosh, Dr. R. D. Thomson, Mr. Thomas Thomson, jun., Mr. Charles Tennant, Mr. Crossall, Mr. Robert Mallett, Mr. Walter Crum, Dr. Ingles.

SECTION C.—GEOLOGY AND GEOGRAPHY.

President.—Rev. Professor Sedgwick (for Geography, G. B. Greenough).
Vice-Presidents.—Leonard Horner, Lord Cole, M.P., H. T. De la Beche, F.R.S.
Secretaries.—Captain Portlock, R. Hutton, M.P. (for Geography, Captain H. M. Denham, R.N.)
Committee.—James Bryce, Sir Philip Grey Egerton, W. J. Henwood, James M'Adam, Major Sabine, H. E. Strickland, W. West, M.D., H. T. M. Witham, Rev. M. Dwyer, of Liverpool, W. B. Clarke, R. Griffith, B. Ibbetson, Col. Silvertop, R. J. Murchison, T. S. Traill, M.D., Rev. James Yates, Professor Phillips, Major Shadwell, Chester.

SECTION D.—NATURAL HISTORY.

President.—W. Sharpe Macleay, F.L.S.
Vice-Presidents.—Dr. Richardson, Professor Graham, Professor Lindley.
Secretaries.—C. C. Babington, F.L.S., W. Swainson, F.L.S., Rev. L. Jenyns, F.L.S.
Committee.—Thomas Hincks, D.D., N. A. Vigors, F.L.S., Rev. F. W. Hope, F.L.S., Pat. Neill, LL.D., Professor J. S. Henslow, T. S. Traill, M.D., Earl of Derby, Rev. W. Hincks, F.L.S., John Curtis, F.L.S., P. B. Duncan, F.L.S., J. E. Gray, F.R.S., Charles S. Parker, Rev. J. Yates, J. E. Bowman, T. Eyton, J. P. Selby, C. Horsfall, R. Ball, S. W. Dillwyn, J. N. Walker, A. H. Haliday, J. T. Mackay, Captain James Ross, Sir W. Jardine, R. Harrison, Mr. Tinney, H. Sandbach, J. Salisbury, Mr. Green, Dr. Duncan, F. Archer, G. Cook.

SECTION E.—MEDICAL SCIENCE.

President.—Professor William Clark, M.D.
Vice-Presidents.—J. Carson, M.D., F.R.S., P. M. Roget, M.D. Sec. R.S., R. Bickersteth, Esq., Professor R. T. Evanson, M.D., M.R.I.A.
Secretaries.—J. Carson, jun., M. D., J. R. W. Vose, M.D.
Committee.—Neill Arnott, M.D. F.R.S., R. Bright, M.D. F.R.S., Hugh Carlisle, M.D., J. Copland, M.D. F.R.S., Professor R. T. Evanson, M.D. M.R.I.A., Richard Formby, M.D., Augustus B. Granville, M.D. F.R.S., John Houston, M.D. M.R.I.A., James Johnson, M.D., James Macartney, M.D. F.R.S., Charles Herbert Orpen, M.D., William Henry Porter, Esq., Charles B. Williams, M.D. F.R.S., John Yelloly, M.D. F.R.S.

SECTION F.—STATISTICS.

President.—Lord Sandon, M.P.
Vice-Presidents.—Colonel Sykes, Mr. G. R. Porter, Mr. J. Heywood.
Secretaries.—Mr. W. R. Gregg, Dr. W. C. Taylor, Mr. W. Langton.
Committee.—Dr. Jerrard, Mr. Hovenden, Mr. Fripp, Dr. Carpenter, Mr. H. Romilly, Col. Briggs, Mr. Corrie, W. C. Taylor, LL.D., W. Wyse, M.P., Mr. Llaney, M.P., Mr. Urquhart, Dr. Kay, Mr. Tuffnell, Mr. Chadwick, M. S. J. Loyd, Mr. Simpson.

SECTION G.—MECHANICS.

President.—Rev. T. R. Robinson, D.D. F.R.S.
Vice-Presidents.—Dionysius Lardner, LL.D. F.R.S., Professor Wheatstone, London, Professor Willis, Cambridge.
Secretaries.—William Ritchie, LL.D. F.R.S., Thos. Webster, Sec. I.C.E., Charles Vignoles, C.E.
Committee.—John Scott Russell, F.R.S.E., John Taylor, F.R.S., Dr. Traill, F.R.S.E., John Robison, F.R.S.E., Davies Gilbert, F.R.S., Geo. Rennie, F.R.S., Rev. John Blackburne, Pres. Sheffield Phil. Soc.
Associates.—John Isaac Hawkins, C.E., William Fairbairn, Peter Clare, George Forrester, Edmund Bury, William Fawcett, Henry Booth, Hardman Earle, Joseph Locke, David Hodgson.

A general view has now been given of the distinctive characters of the late meeting of the British Association, and of its most important recent labours. With this we conclude on the present occasion, leaving the consideration of the papers read before the Sections for our Supplement of next week, which will be chiefly devoted to this subject.

PRINTING.—On the second day of the grand Gutteburg festival, at Mayence, in honour of the inventor of the art of printing, it was resolved that once every five years there should be held at Mayence a general assembly of all the German printers, booksellers, and type-founders. On the third day it was resolved that the 24th of June, 1840, should be the next jubilee in honour of the art of printing.

EARTHQUAKE.—An earthquake took place on the 28th of last May at Martinique, which although violent, was unattended with any volcanic eruption.

ORIGINAL CORRESPONDENCE.

THE RAILWAY MANIA.

TO THE EDITOR OF THE MINING JOURNAL.

SIR,—It may be said of works of public interest in this country beyond all others, that they are commenced or discontinued, advanced or retarded, according to the variations of popular whim. We find in morals what we find in physics, that large bodies are difficult to move, and, when in motion, difficult to controul or direct. The public mind was long ere it could be awakened to the importance of improved inter-communication; but when a vast array of facts and arguments had been brought to bear upon the question, and the lethargy was shaken off, a general movement in the mass was perceptible, and a career was commenced, reminding us strongly of the fatuous period of 1825.

A mere enumeration of these undertakings would be difficult; a full discussion of their many and diversified points, impracticable. But there are some prominent features in inland communication which are fraught with universal interest to the community, and yet so overlooked by the public, that I venture to think you will consider them worthy of a place in your valuable Journal.*

To prepare the way for consideration of a subject upon which too much ignorance prevails, I may remind some of your readers that the same resisting forces are met with by a carriage, whether the carriage be worked upon a railway or upon a common road. They are the same in kind, and only one of the forces (that is, the resistance of the *surface* of the road) can differ in degree, when the two sorts of road are well made. It is difficult to conceive how any one can deny that it is on the point of surface resistance alone, in the economy of road-making, that the edge railway in any measure surpasses another road in the facility which it allows to tractive power. It is admitted that a wheel, with a well-shaped rim, will roll upon a hard iron plane surface with the same facility as a railway carriage wheel will roll on the hard surface of the edge-rail. It must be admitted, also, that the resistance of friction in the *axles*, and other working parts of the carriage itself, is the same whether the carriage run upon one level road surface or upon another; that the resistance of *gravitation* on the same slopes, is equal in all roads; and to deny that the resistance of *collision* is as great upon edge rails as upon any other tolerably good road, is to betray an ignorance of, or want of candour as to facts, established by a long course of published and authenticated railway experience. There are no other resisting forces to the motion of a carriage but the four above referred to (that of the air need not be taken into account); and of these four, it is only that of *surface resistance* which the adoption of an edge rail can remove.

It is this reduction of surface resistance which renders a railway so advantageous in certain situations, where a brisk cross traffic is not carried on, and where all but railway waggons, with their peculiarly-shaped wheels, can without injury be excluded. But we have not only to consider what kind of road will allow of the greatest effect being produced with a given power. There are considerations connected with public traffic of infinitely higher importance to us, and to the public in general; considerations which belong to the statistics and political economy of the country.

With the alleged profits of railway speculation the public in general have little to do. Whatever be the profits or losses to arise from these, I would only say, that the constitution of the co-partnery does not differ in reality from that of any other co-partnery, wherein the wisdom of each partner is directed to personal profit; and his interest is not to break the secret of loss, but rather to extend the delusion, with the view of shifting the burthen from his own shoulders. It is, however, a duty to observe that the unprofitable employment of a vast mass of national capital is to be deprecated; individual speculations are only sacred from legislative controul when their failure cannot in any way compromise interests more extensive than those of the individuals concerned.

Too much is founded upon the reported profits of the Liverpool and Manchester Railway. That line may or may not be useful and profitable; but there can be no analogy between that line and many (if any) others. There is in the traffic on that line no resemblance to the miscellaneous carrying-trade over large districts of the country. To expect that a railway will be profitable every where, is about as sane as to expect that the Clarendon hotel would yield a return in the deserts of Africa.

If we turn to examine the reported profits of the railways in operation, we find almost a blank. In the summer of 1836 there were the following lengths of railway in being, in progress, and in prospect. How much the two latter sums total have since been swelled, I have not calculated:

231 miles completed at an actual cost of	£ 2,905,000
426½ miles in progress. Estimated cost of.....	11,535,000
1430 miles in prospect; the greater part having obtained their Acts of Parliament. Estimated cost of	25,218,890

These are exclusive of railways in Scotland and Ireland, and also of sundry English lines of more recent promulgation.

The only companies that I find paying dividends, are the Liverpool and Manchester; the Stockton and Darlington; and the Greenwich. (?)

If we turn to examine the probable quantity of business, which these routes will obtain, we find no great cause for the congratulation of shareholders. From official returns of all coaches licensed in London, to carry passengers thence to different parts of England and Scotland, and of all coaches licensed to carry passengers from other parts of England to different parts of England and Scotland, it appears that the annual transport of passengers, even supposing all mail and stage coaches to be always full, does not exceed 597,150,420 passengers carried one mile, or by division, about 19,000,000 persons carried a distance of 31 miles. Now 420,000 of these passengers are carried annually from end to end of the Liverpool and Manchester line (31 miles), so that we are warranted in saying that this railway has $\frac{1}{45}$ part of the whole passenger trade, and the other 44 parts will fall to be *divided* among the 2056½ miles of railway, and the 19,000 miles of turnpike travelling.

It is true that facility of communication would naturally produce some increase: the increase of passenger traffic has been 135 per cent. since the railway was made between Liverpool and Manchester, but that increase is almost altogether due to the intimate commercial relation between these towns. A similar increase may perhaps occur in some other instances, it cannot in many.

I have said above that it is desirable to remove the surface resistance of all roads, whether animate or inanimate power be employed thereon; and I suspect that railway promoters are ignorant how far surface resistance, which is erroneously called "*friction of the road*," can be reduced, as will appear from the following table, which I constructed, and gave in evidence before the Committee of the Lords on Steam Carriage Tolls, in 1836*:—

A comparative statement of first cost, annual maintenance, and economy of tractive power upon different kinds of roads; the supposed carriage traffic being 250,000 tons per annum:—

	EDGE RAILWAY	Old road laid with blocks of granite for wheels to run on.	Cassell's bituminous surface laid on an old road.	Good London pavement, width 15 feet.	Broken stone road on a rough pavement foundation.	Broken stone road on a foundation of cement.	Gravel or broken stone road.
First cost	£20,000*	£2,500	£1,000	....	£2,000	....	£2,000
Annual maintenance per mile.	£400, not providing for depreciation.	£50, not providing for depreciation.	£75, providing fully for keeping it up.	£79, providing for renewal every ten years.	£133 providing fully for keeping it up.		£372, providing for renewal every ten years.
Tractive power required to move one ton on a level.	10 lb.	12½ lb.	15 lb.	32 lb.	43 lb.	43 lb.	140 lb.

* In all but the first column of this table, I avail myself of land already paid for.

The last line of this table is completely at variance with Mr. Stephenson's notions of road surface resistance. He says the resistance on a common level road is ten times greater than on a railway; but in his estimate an indifferent turnpike road is compared with the best edge railway. The above table however shows that on a well-made country turnpike road, the surface resistance is little more than four times that upon an edge railway; and the edge railway accomplishes even this saving in surface resistance at a much greater expense. It also appears that the surface resistance saved by a railway is more than two-thirds when compared with London pavement; but this also is obtained at a disproportionately greater expense in providing for deterioration. It further appears that the first cost of a railway is at least twenty times more than that of a common road "prepared in the best manner," and much more expensive in annual maintenance. Road trustees, commissioners, and indeed the greater portion of road surveyors, are ignorant of the improvements which may be, and have been recently, at a cheap rate, made on road surface.† This is evident from the conflicting evidence in the Report on "Turnpike Trusts and Tolls." ‡

As a long and careful study of the subject of inter-communication, has impressed me with the vast comparative importance of the branch of the subject connected with the use of steam as a locomotive power on common roads, and satisfied many, as to the great benefits that must arise to the public generally from the cultivation and encouragement of *that* department of the inquiry, I shall glance briefly at what has been and may be done in connexion with that object.

I am the last person to overlook or undervalue the real benefits which may and must arise from edge railways, when projected and established under those peculiar (but rarely occurring) circumstances to which they are especially applicable. But those circumstances must be regarded, as in every case, comparatively speaking, individual, local, and exceedingly limited in their nature: while the benefits arising from the general adoption of steam in place of animal power, in connexion with *all* public conveyances, upon flat plate roads or turnpike roads, would be co-extensive with the whole population of the country On the other hand, while the cost of edge railways, even for the very limited circumstances which call for or justify the production of them, is so enormous, as to render the success of them, as a pecuniary speculation, problematical, even under the most favourable circumstances: the cost of steam carriages for common roads, need not in any case be disproportionate to the probable amount of the work to be accomplished by them. A railroad, intended to convey five hundred passengers a-day, will cost as much as one intended to convey 5,000 or 50,000. Whereas an establishment of steam carriages will of course be exactly correspondent with the probable calls upon it, and may be increased or diminished as the case may from time to time require.

To cause a steam carriage to run on any road, it is sufficient to turn the wheels; by the adhesion or attachment of which, on the surface of the road, the power of progression is gained in the direction of the wheel's rotation. This essential mechanical condition has been satisfied in regard to common road locomotion, and the possibility of travelling by steam, at high velocities, on the turnpike roads of the country, has been fully established.

Steam carriages on common roads offer this immense advantage, that they are able to run on the long-established and well-peopled roads of the country, thus preserving the inns, towns, and interests located on existing lines, which must otherwise suffer by the edge railway system. They preserve to invalids, ladies, and children, their wonted accommodation: also to commercial travellers who stop and transact business in all the towns, and who by so doing render their goods easily attainable, and give that constant support to inns which makes them so convenient for occasional travellers. They preserve to those who travel for pleasure, the noiseless and luxurious private carriage, and the privilege of selecting their own time, conveyance, and chosen company, an independence quite inadmissible by railway transit, and (which we hold to be as weighty an argument as any of these) it prevents beautiful natural scenery from being converted into deformity, by levelling hills, filling up valleys, and substituting for graceful slopes and windings, a stiff rectangular embankment.

In the year 1831 a Select Committee of the House of Commons, after examination of Mr. Davies Gilbert, Mr. Farey, Mr. Trevithic, Mr. Telford, Mr. M'Neill, myself, and other engineers; as also certain steam carriage patentees, reported, *inter alia*, their conviction—

1st. That carriages can be propelled by steam on common roads at an average rate of ten miles per hour.
2d. That at this rate they have conveyed upwards of fourteen passengers.
3d. That their weight, including engine, fuel, water, and attendants, may be under three tons.
4th. That they can ascend and descend hills of considerable inclination with facility and safety.
5th. That they are perfectly safe for passengers.
6th. That they are not (or need not be) if properly constructed, nuisances to the public.
7th. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses.
8th. That as they admit of greater breadth of tire than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of road, than those coaches drawn by horses.
9th. That rates of toll have been imposed on steam carriages, which would prohibit§ their being used on several lines of road, were such charges permitted to remain unaltered.—*Report on Steam Carriages*, 1831.

Previous to the date of this report, Sir Charles Dance, who had purchased two steam carriages from Mr. Gurney, had made 396 regular journies, conveying several thousands of the public, between Gloucester and Cheltenham, on the turnpike road, without an accident, and at less than one half of the coach fares. Meeting, however, with the determined opposition, well described in the Report just quoted, Sir Charles was compelled to abandon his spirited efforts for the advancement of this great improvement.

Shortly after the Report of the Committee of the House of Commons in 1831, the railway mania seized the public mind, to the prejudice of the cheaper system. In the interval many patentees and other individuals have devoted time, attention, and capital, to the introduction of steam carriages. But these have in most cases been the unconnected efforts of men labouring to introduce only their own inventions encumbered by a number of fancied improvements. They have exhibited the partial efforts of men who under rate the defects and magnify the merits of their own invention, and are disinclined to adopt any improvement, however good, which did not originate with themselves. There has been no hearty and combined co-operation in the various endeavours to bring forward this object.

Mr. Gurney, to whom is due the honour of introducing steam carriages on the common road, in 1831, was driven from his favourite occupation by legislative interference, and was dispirited by moral, not physical difficulties. Still, enough was in the interim done by Mr. Hancock, Colonel Macerone, and others, to keep the practice alive, and to confirm the conviction in all unprejudiced minds, that the desideratum was attained, and that, under good management, it could be beneficially used for public service.

In November, 1833, an experiment was made by some engineers ‖ for their own satisfaction; and their report was, that "there can be no doubt that with a well-constructed engine, a steam carriage conveyance, on the turnpike roads between London and Birmingham, at a velocity unattainable by horses, and limited only by safety, might be maintained."

In April, 1834, Mr. Gurney again petitioned the House of Commons for a repeal of the prohibitory tolls. The debate on this petition induced Lord Althorp to consent to a Committee of Inquiry. The Committee sat till the end of the session, and reported that they earnestly recommended the inquiry to be resumed early in the next session. In the following

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* Had I not been the author of two of the following works, I should have tendered my views to you in the shape of an "Article on the Railway Mania," and, according to custom, placed the following works and papers at the commencement of the same, as I shall have occasion to refer to them in the course of my remarks:

I. *Parliamentary Reports from Select Committees of the House of Commons on Steam Carriages, July*, 1831; *on Gurney's Case, 17th July*, 1834; *on same, 17th July*, 1835; *on Turnpike Trusts and Tolls, 9th August*, 1836; *from Select Committee of the House of Lords, on Bill for Tolls on Steam Carriages, 19th July*, 1836.

II. *Parliamentary Papers on Turnpike Trusts, ordered by the House of Commons to be printed 4th February*, 1836.

III. *Remarks upon Proposed Railways.* By Investigator. 1831.

IV. *Treatise upon Locomotion and Interior Communication.* Third Edition. By Alexander Gordon, C.E. London, 1836.

V. *Observations on Railways and Turnpike Roads.* By the same author. March, 1837.

† Report 1836, p. 81.

† Dr. Lardner, in his treatise on the Steam-Engine, states the surface resistance of a turnpike road at twenty times greater than on a railway; an assertion completely at variance with the fact just stated.

‡ In the House of Commons, 4th Feb., 1836.

§ In another part of this report, the Committee express themselves more strongly using the words "utterly prohibit."

‖ Vide Report in "Gordon on Locomotion," p. 96, signed by Mr. Telford, Colonel Paisley, Mr. Donkin, Mr. Bramah, Mr. Simpson, Mr. Field, Mr. M'Neill, and other engineers.

session the matter was therefore again resumed in the Commons, and the Committee finally reported that—

In addition to the difficulty existing in 1831 in the way of tolls, and which caused the suspension of Mr. Gurney's operations, your Committee find that 150 Turnpike Acts have passed since that period, containing similar prohibitory clauses with respect to steam carriages, making in the whole upwards of 200 (!)

Under the conviction that the prohibitory tolls imposed by Parliament in 1831, have been the cause of almost incalculable loss to Mr. Gurney—a loss in no degree exaggerated by him in his petition to the House last Session, your Committee conceive that it would be impossible, in common justice, for the Legislature to do less than to take steps to repeal such portions of certain Acts as imposed prohibitory tolls on steam carriages.

Mr. Gordon, a civil engineer, who has especially applied himself to the subject of steam carriages for a number of years, and written extensively on it, is asked—

828. Is it your opinion that, if the capitalists who were at the time contracting with Mr. Gurney for the use of this carriage had not been impeded by those heavy tolls, Mr. Gurney's carriages at this time would have been both practicable and in general operation, and would have been paying a high profit to Mr. Gurney?—My impression is, that upon the road to which I have alluded, and upon several other roads, they would now have been in profitable operation, both to speculators in the carrying trade, and also to Mr. Gurney, the patentee, by necessary consequence.—*Report*, ordered to be printed 10th July, 1835.

The Committee concluded their Report by recommending "that the prohibitory tolls should be repealed, and a General Act passed, fixing tolls on steam carriages.

In pursuance of this Report, an act to repeal such portions of all acts as impose prohibitory tolls on steam carriages, passed the House of Commons, without opposition, in July, 1836. The hereditary legislators, however, entertained "serious objections to the bill referred to them; and they are not of opinion that these objections are counterbalanced by any great public advantage." (!)—p. iv.

"No public advantage" forsooth, to result from the adoption of inanimate for animate power in so large a branch of national industry as the carrying trade! Are there neither political, commercial, agricultural, nor moral advantages? No increase of industry and happiness by extending the poor man's field for the exercise of labour, his only exchangeable commodity? None in the diffusion of knowledge? None in the adoption of non-consumers of food instead of animals, amidst complaints of over-population? None in the augmentation of the country's mental power, without any proportionate demand for food? No commercial or agricultural advantages in saving of carriage on marketable commodities? None in the prevention of monopoly? No moral advantages of extensive and permanent utility, by cheapening production, and saving the consumption of the food of the country? None of these to counterbalance their "serious objections to the bill?"

They cannot mean this; they cannot be so ignorant of the advantages which have resulted from machinery in the cheap production of clothing, husbandry, furniture, and every other article, whether consumed by plebians or patricians. Surely they must be aware that our high position in the scale of nations is somewhat connected with our scientific mechanical improvements, if not so much so as with the hereditary talent so eminently displayed in our political machinery! Or surely, whatever be their Lordships' knowledge of the results of mechanical improvements, they do not appear to possess much power of anticipation in connexion with the history of British manufactures. Yet what are these advantages when compared with the objections? What objections?—mechanical? political? moral? No, none of these. "*Serious Objections*," of which we remain ignorant.

I have yet more to say, Mr. Editor, but shall beg a further portion of your valuable columns next week. I am, Sir, yours, &c.,

Fludyer-street, Westminster, Sept. 15. ALEX. GORDON.

HOT-BLAST.

TO THE EDITOR OF THE MINING JOURNAL.

SIR,—A severe indisposition has prevented me from sooner fulfilling my promise, and offering you my excuses in regard to some incorrect remarks I made in my last letter. I did not "well understand" the passage to which I alluded—you may depend that I did not intend to engage in a polemic of words. I shall be glad to throw some good idea on the subject—that motive only decided me to submit you some results of my experiments on the subject of hot-blast. They were not properly understood—they were not, in fact, well explained then, but now I shall endeavour to make them easily comprehend. I have also to answer Mr. W. Wood's reply of the 29th August—that will also be the explanation of my last letter.

The statement I have given of the strength of iron, was in order only to show that, contrary to that gentleman's opinion, iron can be made of a superior quality by the hot-blast process, when the materials are conveniently treated. Stating of the strength comparatively, I have taken the strength of iron manufactured in England by cold-blast, which is considered the best, and I compared to it the strength of the best iron manufactured by hot-blast in England and in Scotland. From that statement it is easy to judge that the hot-blast iron, inferior in strength, may possibly be ameliorated by some variations in the treatment of the materials, since, in some cases, it proves to be quite as good, if not superior, to that made by the cold-blast. The superiority of strength in the iron is not caused by the chemical or physical difference of the materials which produce it, as your correspondent pretends it is, but from the manner from the processes by which those materials are treated during the metallurgical operations.

I do not think I have been much refuted with the futile explanation of Mr. Wood, of local circumstances; and when I prove by facts that, contrary to his opinion, iron of good quality is manufactured with a great diminution of expenses by the patent hot-blast process. It appears to me that the processes should vary, in accordance with the nature of the materials, &c.; and as far as I am in the situation to satisfy his inquiries relative to the strength of iron manufactured from the same materials by the cold and hot-blast, I can tell him that, at the Butterley Iron Works, the cold-blast iron was decidedly inferior to that manufactured by hot-blast. The specific gravity of cold-blast iron has been so often published, that I did not feel warranted to repeat it again; for instance, I have taken that of Low Moor metal, No. 1, which was 6.9793, just what I should have supposed, judging by comparison the No. 1 cold-blast, of good manufacture, being always of about 7.0000, with a variation of some hundredth or thousandth. The difference of the specific gravity from the No. 1, to the casting metal or No. 3, is generally of two-tenths in the produce of the same furnace; and in all the engineers' works and publications, metal of that specific gravity is considered good. The specific gravity of the hot-blast iron of the Buttlerley and Alfreton Iron Works, being identical with good metal manufactured by cold-blast, I think that was sufficient to prove that iron of a good quality may be also made by hot-blast, especially when Mr. Wood told us in his letter that the inferiority of hot-blast iron was to be attributed to the chemical composition; to help him in the conclusion of his analysis, I deduced the following:—If the specific gravity of pure malleable iron is 7.7880, the lighter the cast-iron is the impurer it will be, because that deficiency of specific gravity is produced by a greater quantity of foreign matters in the cast-iron; and in order to exemplify it, I give the specific gravity of charcoal iron, No. 1.—Ditto, of good hot-blast, No. 1.—Ditto, of bad hot-blast, No. 1. I did not mention the specific gravity of cold-blast, because, in my conviction, it does not differ from the good hot-blast, and has quite a similar specific gravity, as it may be easily verified.

On the 17th of July, Mr. Frederick Burr, in showing the superiority of cold-blast iron, goes a certain length to explain the phenomena of the reduction of iron ores by the process of hot and cold-blast; it appears to me that he gave rather an incomplete idea of the mutual functions of the re-agents. I shall say, in accordance with a very elegant paper of M. F. Leplay, Ingineur des Mines, published in the "Annales de Chimie et de Physique," vol. lxii., Juillet, 1836, on the reduction of iron ores, &c.:—"That in every blast-furnace where the oxides of iron, lead, copper, and tin are reduced, it is not because there is no appreciable contact between the minerals and the carbon, that the operation does not succeed, when the mixture is as complete as possible between these two re-agents; but, on the contrary, the regular working of the furnaces is more perfect when the contact is more insignificant; that during almost the whole of their stay in the furnaces, the minerals are not essentially in contact with any acting principle, except with the oxide of carbon, from which I conclude that it is that gas which produced in these furnaces the phenomena of reduction and concentration, till now attributed to the carbon. Since that time all the phenomena observed till now, relatively to the action of the carbon in the metallurgical processes, offered themselves to me as evident corollaries of this principle."

I believe, I have demonstrated that the treatment of oxides of metals into a close compass, either by cementation or by means of mixture with charcoal, is nothing more, in every respect, than a cheap and simple way to submit them to the action of oxide of carbon That the charcoal acts more rapidly by way of mixture than by cementation, not because it is then in more intimate contact with the oxide to be reduced, but only, and this difference is principally with the carbonic acid produced by the reduction, and which, in this case, is reconverted more speedily to the state of carbonic oxide. That the blast-furnaces are established on the same principle; that they differ from the close apparatus of cementation only, that the heat necessary for the reaction of the oxide of carbon, instead of being applied externally, is produced in the same compass where that gas is produced and acting. That in all furnaces, without any exception, the oxide of carbon is prepared by the reaction of the atmospheric air on the carbon; in all the air furnaces the atmospheric air is projected on the carbon, and creates a current of carbonic oxide, which is revived constantly. In the apparatus of cementation the air is interposed mechanically between the solids contained, and the same molecule of carbonic oxide can react during all the time of the operation, whatever may be its length.

There is between the cementation of oxides and that of metal, this essential difference, that, in the first instance, even in neglecting the reciprocal action of the solids, there only wants a single molecule of oxygen to be intermixed with the brasque (the internal lining of the furnace or crucible with charcoal), in order that the reduction should begin and develope an atmosphere of oxide of carbon, always increasing. In the instance of metals, on the contrary, the power of the atmosphere of oxide of carbon remains always the same, and is produced by the atmospheric air intermixed in the brasque. This makes it easy to understand why the cementation of metallic iron cannot take place in boxes, in which the charcoal is too finely divided—facts, of which the cause appeared always inexplicable. It is possible now to state twenty facts of the same kind*, borrowed of all the branches of metallurgy, which, from being incomprehensible are now necessary.

The foregoing developments sufficiently show how much the preceding established principle is fruitful in its consequence—it may be expressed so in its most general acceptation.—"The carbonic oxide reduces all the compounds, and carburets all the metals which can possibly be reduced and carburetted by cementation."

From the above statement, it is easy to conclude that the phenomena of reduction effected in the blast-furnaces, are operated by the same gases, both in the treatment with cold and hot air; and that not any difference will exist in the quality of the produce, if the operation is carried on according to the nature of the materials. In using hot air the same phenomena take place, only the oxygen being warm, combines more readily with the carbon when it is introduced in the furnace; and the affinity of the metal for the carbon being greater at a high temperature, is better effected than when operated in the refrigerating circumstances of the cold-blast.

It yet remains to explain the functions of hydrogen gas, which your correspondent seems to suppose to be the cause, in some degree, of the inferiority of hot-blast iron; and at the same time that it produces, as he said, a waste of carbon. From attentive experiments I made in reducing pure per-oxide of iron, and converting it into steel by a contact with carburetted hydrogen gases, I am certain that the carburetted gases disengaged from the raw coal in the blast-furnace, does effect the same phenomena of reduction and cementation as the oxide of carbon. I have, in favour of this view of oxides, reduced and cemented a metal by gaseous carburets of hydrogen, the metallurgical application of coal gas to the cementation of steel, for which Mr. Mackintosh has had a patent granted, and which has produced steel of a very superior quality. Berzelius also has established the atomic composition of metallic oxides by the action of hydrogen. The theory of the functions of carburets of hydrogen should be expressed, as that of the oxide of carbon mentioned before.

Another proof of the foregoing principles, is the application of the hydro-cyanate of potash to the hardening operation on iron, which takes place by the decomposition of the cyanogene, which cements the iron bearing the nitrogen, after it has absorbed the carbon.

The saving effected in using hot air may be accounted for, first, from the saving of the expense of cokeing; secondly, from avoiding the waste of a re-agent gas, namely, the hydrogen, which is capable, as well as the oxygen of the air, to convert the carbon into that gaseous state necessary for the carburetting and cementing functions; thirdly, by saving those proportions of carbon which would have been volatilized, combined with the gases expelled from the coal, amounting, in some cases, when the coal is of a gaseous nature, as in Scotland and in Derbyshire, to 25 per cent. of the raw coal, or at a third of the carbon contained, as it may be deduced from the average analysis of Dr. Thomson on the coal of those countries, where the amount of the carbon is 74 to 45 per cent., the same coal having produced by carbonization, 52 per cent. for Derbyshire; ditto 40 per cent. for Scotland, in which are included the ashes; fourthly, in keeping always the compass in that high temperature better effected for the reducible and carburetting functions, as well as for the formation of the cinders, &c., silicates decomposed from the ores; fifthly, allowing the processes to proceed faster, and to give more produce, as in Scotland, from eighty to ninety tons, instead of thirty tons weekly, &c.

The deficiency of strength in some cast iron manufactured by hot-blast is certainly produced in consequence of the use of that system, but it may be improved; in Scotland, for instance, the air introduced is at a high temperature, perhaps + 1200 deg. Fah., the volume considerable, 18 to 20 blasts a minute; at a low pressure, 1½ or two pounds per inch, in the best circumstance, to carburet the metal as much as possible, and to escape the destruction of its carbon when it is falling in the crucible; after that, most probably that inferior metal is melted, with little attention to saturate the siliceous acid with earthy matters, in order to escape its reduction, and to facilitate the formation of those double-based silicates, which are known by the name of cinders, and, consequently, if the siliceous acid of the ore is not saturated sufficiently by the metalloide oxides, as lime, manganese, &c., naturally the contact of the iron, the power of such a reducible atmosphere will facilitate its conversion into silicum, increase the produce, diminish the specific gravity, and destroy the state of agglomeration of the molecules of the iron, which produce its strength; but, notwithstanding the particular case in favour of the hot-blast system, I am convinced that iron can be made of a very superior quality, and cheaper than by cold-blast in many circumstances.

A very great advantage of hot-blast is its application to the reduction of the pure oxide magnetic ore, without the help of any flux whatever, but only by the reducing power of the oxide of carbon, formed speedily after its introduction in the furnace, without injuring the metal carburetted when it falls into the crucible, that the operation is performed with a great saving in fuel, &c.

I hope you will excuse the Gallicisms of my letter in favour of the motive which has determined me to make my efforts, in order to destroy the really too strong prejudice against the application of a principle so teeming in its results. I am, Sir, yours, &c.

E. DUCLOS DE BOUSSOIS,
Chemical Works of Church, Sept. 13. Du Corps des Mines.

OIL GAS.—M. Auguste Laurent has again urged to the French Academy of Sciences, the advantages of using gas drawn from the oil of bituminous slate for lighting manufactories. He is convinced of its economy, and obtains seventy-two cubic feet of gas from every two pounds of oil, and the intensity of the light is such that a socket of sixteen or eighteen holes is equal to fourteen or fifteen wax candles.

NEW CAVERN.—A few weeks ago, the miners at a lead mine about a mile distant from the castle, near Castleton, burst suddenly into a capacious cavern, almost entirely lined throughout with a variety of the most beautiful incrustations, chiefly stalactical, many of which were brought away as specimens to enrich the cabinets of the curious.—*Sheffield Iris.*

* It may be understood now, for instance, why an iron-blast furnace cannot work if the minerals and carbon are mixed; and why, on the contrary, these two substances must be charged by thick and distinct horizontal lyings; it is, consequently, to the vertical direction of each gaseous molecule, that one can at every moment produce the maximum of useful effect, which consists in its reaction on the mineral when it is to the state of carbonic oxide, and on the carbon when it is to the state of carbonic acid. In the fortuitous disposition produced by a mixture, the same thing cannot take place, and it may be understood literally, such possible disposition, in consequence of which two molecules of carbonic acid and carbonic oxide should pass through the furnace without meeting anything, except the first, the mineral, and the second the charcoal; and at the end, without producing any effect, the different disposition, but yet more distinct of the minerals and carbon in the furnaces where the ores of lead, copper, and tin are reduced, is explained in quite as rational a manner.

SOUTH WELCH COAL BASIN.

[We insert the following letter, which has been addressed to the Editor of the "Merthyr and Cardiff Chronicle," as being of interest to our readers].

SIR,—Mr. Forster, in a series of interesting observations on the South Welch Coal Basin, published in the first part of the transactions of the Natural History Society of Northumberland, gives the following table as exhibiting the results of an examination of several varieties of Welch Coal:

Seams in a Line of Section, from North to South.	Volatile matter per cent.	Carbon per cent.	Incombustible earthy residium per cent., leaving in combustion.
STONE COAL.			
Seam on Mynydd Bach. ..	—	—	——
Llanelli	8.65	89.85	Pale yellow ashes 1.5
FREE-BURNING COAL.			
Clynwernon Seam.....	14.0	79.0	Heavy reddish ashes.. 7.0
Penbry Seam	14.5	82.0	White ashes 3.5
BITUMINOUS COAL.			
Gile Gile Seam	16.8	80.6	Red ashes 2.6
Loughor Colliery, 5 ft. seam	10.0	78.5	Ditto 2.5
Globras seam, Adair Col...	27.5	72.2	Yellow 2.3
SEAMS IN DIFFERENT PARTS of the COAL BASIN.			
Cox's stone coal, Cwm Tw.	70.5	91.5	Yellow ashes..... 1.0
Pool coal, west of Llanelly	19.9	77 8	Reddish ashes 2.4
Bushy seam, Llanelly	15.9	81.6	Ditto ditto 2.5
Great seam at Merthyr....	13.4	85.6	White ashes 1.0

A glance at the foregoing table will show how various are the proportion of the matters entering into the composition of coal from the stone basin. One description of stone coal containing eight and a half parts out of 100 of volatile matter, while one of the bituminous varieties yields upwards of twenty-seven parts, and while one sort leaves on combustion only one per cent. of ashes, another leaves seven per cent. The great seam at Merthyr is that from which the greater portion of the coke for the blast furnace is produced, It is coked in heaps in the open air, and produces a close grained coke of a silvery lustre, and very free from sulphur. Your obedient servant, ZETA.

MECHANICAL POWER OF ELECTRO-MAGNETISM.

The following letter from New York will show that considerable progress is being made in America, in the application of electro-magnetism as a motive power. The results obtained, although on a small scale, are very interesting, and we do not see any reason to believe but what the experiment may be equally successful when brought into operation on a more extensive one. The field thus opened is vast, and we shall be glad to hear of greater attention being directed to the subject in our own country, than has hitherto been the case.

"Having seen the electro-magnetic machines of Mr. Davenport, I am free to confess that I cannot discover any good reason why the power may not be obtained and employed in sufficient abundance for any machinery—why it should not supersede steam, to which it is infinitely preferable on the score of expense, and safety, and simplicity. I do not very clearly understand the principle (something about changing the poles from positive to negative, or from north to south), and *vice versa*, in rapid succession; but this is of little consequence, as I shall be able to send you, probably by the next packet, a pamphlet containing a full exposition, with illustrative engravings. Mr. Cook, who is associated with Mr. Davenport in the patent, is now engaged in preparing this pamphlet, and he has promised me the first copy that is printed. They have patenteed their invention in France and England.

"Before I saw the machines, I had two doubts as to the more extended application of the power. One of these I stated in my last, viz., whether the enlargement of the apparatus would be attended by any very great increase of the power; the other was founded upon what I supposed to be a necessity in the construction of the machine. I had understood that the revolving wheel was formed of iron bars, upon which the coated wire was wrapped or wound, in order to form the communication with the galvanic batteries, or cylinders of alternate zinc and copper; and that this wheel revolved within the periphery of a fixed circle, also magnetised, and having on its inner surface certain points at which the points or poles of attraction and repulsion were established. Somehow or other I had formed the idea that the space between the outer surface of the revolving wheel, and the inner surface of the fixed circle, was of necessity exceedingly minute, so that in fact they did all but touch; and I conceived that it would be impossible to construct large machinery with such nicety of adjustment as to effect and retain this close proximity, without the danger of coming into actual contact. But I find that the space between is ample to allow of any reasonable play; even in the small machines, with the comparatively trifling degree of power employed, it is full a quarter of an inch; and with the increase of power it may doubtless be enlarged.

"The last machine constructed by Mr. Davenport occupies a surface of about eighteen inches square—that is, eighteen inches on each side, and consists merely of a platform, having upon it an iron circular frame, with an arch extending from side to side above it, a spindle in the centre playing in this arch at top, and in a socket below, and on this spindle an incomplete wheel, formed by two cross-pieces of iron, with segments of a circle at the four extremities. It is in fact a wheel, with four breaks in its periphery. Some hundreds of feet of isolated, or coated, copper wire are wound around the cross-pieces, and also round the fixed circular frame; the connection with the galvanic batteries, which are three small cylinders, each consisting of six concentric tubes of zinc and copper, the outer one scarcely larger than a quart pot, is, as usual, by small rods of copper. The revolving wheel is six inches in diameter, and weighs about six pounds. Attached to the upright spindle is a small cog-wheel, which may be made to work in other wheels, with axles, for the purpose of showing how great a weight can be raised from the ground.

"With the three batteries acting on it, the revolution of the wheel was 1000 times in a minute; and these 1000 revolutions raised a weight of 200 lbs. one foot. The first machine made by Mr. Davenport, which is much smaller and has but one battery, raised but 24 lbs. He is confident that with a number of batteries, or one very large one—say as big as a barrel—there would be power enough to drive the largest machinery; while the cost of construction would be reduced to a fifth, or perhaps a tenth, and that of attendance, fuel, &c., now forming so heavy an item in the expenses of steam-power, would be almost done away with. Half a barrel of blue vitriol and a hogshead or two of water would send a ship from New York to Liverpool; and no accident could possibly happen, beyond the breaking of some part of the machinery, which is so simple that any damage could be repaired in half a day. Surely it is a great and vastly important discovery, and the wildest imagination can hardly grasp the wonders in achieving which it may, and doubtless will, become the instrument."

HOT SPRINGS IN AFRICA.—We extract the following account of some remarkable hot springs in the province of Bona, from a letter recently received from that place:—"About half a league up the Seybouse, beyond the camp of Medjez-el-Ammar, is a small plain, entirely covered with white cones, looking like an Arab encampment, with fumes of vapour issuing from some of them, and resembling smoke; the water, which emits a strong sulphurous odour, boils up from the soil, and deposits round the orifice of its escape the saline and earthly particles held by it in solution, until, by the accumulation of circular layers, a cone is formed over the hole, and the passage of the watar obstructed. The spring then pierces for itself an exit in some other spot, and thus the plain has become covered with these conical heaps. The principal source is very remarkable. The water comes out of a high rock, and deposits over its surface layers of matter of snowy whiteness. When the sun shines on this magnificent cascade, it produces all the prismatic colours of the rainbow. The thermometer, when immersed in the water, rises to 36 deg. Reaumur, or 113 deg. Fahrenheit; and this great heat, added to its strong impregnation of sulphur, renders the water exceedingly efficacious in cutaneous and rheumatic complaints. The Arabs attribute supernatural powers to these springs, as appears from their name, *Hammamm 'skhoutin*, signyfying The Cursed Baths. The Romans had erected here a magnificent building, and the remains of columns, arches, &c., attest the care and the taste with which they endeavoured to avail themselves of the natural advantages of the place."—*Galignani's Messenger.*

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The Mining Journal
AND COMMERCIAL GAZETTE.

SUPPLEMENT---XXIV.

SEVENTH MEETING OF THE BRITISH ASSOCIATION.

The principal features which distinguished the late meeting of the British Association, have been already so fully discussed, both by ourselves and our contemporaries, that but little remains to be said, on continuing our Report of the proceedings. In executing this task, it is of course our object to select those subjects only, which will be found to have immediate connexion with the objects of our Journal, and for this reason our attention will be chiefly confined to the proceedings of the Sections devoted to Chemistry, Mineralogy, Geology, and Mechanics—while those of Zoology, Botany, Anatomy, Medicine, and Statistics, will not afford matter which it enters within our scope to treat upon. In making this selection, we shall freely avail ourselves of the labours of our contemporaries, and for some of the information have to acknowledge our obligation to the *Athenæum*, which for the fullness and accuracy of its reports deserves the highest commendation.

Among the communications brought before the Association of a practical nature, and interesting to the miner and metallurgist, those relative to the iron manufacture, are of the highest importance; and as this subject has recently occupied a large space in our columns, and has deservedly excited much public attention, we shall on the present occasion bring together all those reports and proceedings having reference to it, placing them in such order as to convey a clear idea of all that transpired on the subject.

We have to acknowledge our obligations to Mr. George Crane, of the Yniscedwin Iron Works, for a copy of the paper read by him before the Section of Chemistry and Mineralogy, containing a full and valuable account of the very important discovery he has recently made, of the mode of smelting iron with anthracite or stone coal—a subject to which we have on several occasions directed attention. The full effects of this discovery it is at present difficult, perhaps impossible, fully to foresee; but it may be said, with some degree of confidence, that the extensive application, which doubtless awaits it, together with the general adoption of the hot-blast process, which now seems so probable, must in the course of a few years effect a great revolution in the iron trade, transferring it to localities where it was before unknown, and in all probability greatly increasing even the present immense consumption of iron, from the admirable economy with which the operations for its manufacture will be conducted, and the consequent cheapness of the metal.

The vast importance of the iron trade at all times, but more especially at the present, when such extensive changes are in progress, has occasioned us to devote a large space in our columns to its consideration, and we feel pleasure in bringing together and circulating among the parties most interested in the subject, the mass of valuable and authentic information, which nearly fills our present Supplement; in which, in addition to what passed at the meeting of the Association, we insert a communication lately received from our able Correspondent, Mr. Wood, which has necessarily been deferred till now from the press of other matter.

In a selection like the present, it is unnecessary to insert the papers with strict reference either to the Sections in which they were read, or to the date of their communication; our arrangement will, therefore, be formed on the plan of giving the best general view of the subject, without attention to these particulars, further than may be consistent with convenience.

Both from the novelty of the subject, the interest it has excited, and the imperfect information yet made public respecting it, we are induced to give the precedence to Mr. Crane's communication. The proceedings of the Association, with reference to the "hot-blast," will then follow in a connected form, together with such other less important information relative to the properties of iron, as we may glean from different Sections—thus giving a clear view of those proceedings in which we conceive our readers will feel the greatest interest, so far as can be done within the compass of a single Supplement, and reserving the report of the Geological Section, &c., for a future Number.

On Monday, the first day of the meeting, the following communication "On the smelting of iron with anthracite coal" was made by Mr. George Crane, of the Yniscedwin Iron Works, to the Chemical Section of the British Association.

The great extent of the deposit of that description of fuel called anthracite, or stone coal, in the Mineral Basin of South Wales, accompanied, as it is, with iron mine in great abundance, and of good quality, has long made it an object of great interest to parties connected with that district, to discover some method of applying that description of coal to smelting purposes. One of the earliest patents enrolled in this country for this object, was that of Mr. Martin, in 1804. From the mode detailed in his specification, there does not appear to have been any peculiarity in his process; he evidently expected to have succeeded in using this fuel by the only mode of blowing a furnace then known, that by cold-blast. Another patent was taken out about twenty years afterwards, for a mode of forming a conglomerate coke, composed partly of the small of the anthracite veins, locally called culm, with a sufficient portion of the small of the bituminous, or binding veins, to cement the whole, when coked in an oven together; had this latter plan been attended with success, its application would of course have been limited to those localities where the two descriptions of coal were to be found near each other.

The Yniscedwin Iron Works, which are in my possession, are placed upon the anthracite formation. Until I discovered the method of applying this particular description of fuel to the smelting of iron ore, I was obliged to avail myself of the coal of the bituminous veins, obtained from the adjoining parish of Rillybebill, for the supply of the blast-furnaces at Yniscedwin. During the fourteen years in which I have been engaged in the iron trade of South Wales, I have had my attention anxiously directed to the application of anthracite coal to smelting purposes, and at different periods, at a large outlay, tried a variety of plans, but without success, until the idea occurred to me that a hot, or heated blast, upon the principle of Mr. Neilson's patent, might, by its greater power, enable me to complete the combustion of this peculiar coal. I have now the pleasure of reporting to this meeting, that I have completely succeeded in the application of anthracite to the smelting of ironstone and ore.

That I have used no other fuel in a cupola blast-furnace since the 7th of February last, and that the success of the experiment in the combination of hot, or heated air, with the coal in question, as fully detailed in the specification of my Patent of improvement, enrolled in March last, has been in every respect of so satisfactory a description, whether with regard to the quantity of the iron produced, the quality of such iron, and the economy of the process, that I am now, and have been for the last three months, actively engaged in making the necessary preparations for the introduction of anthracite coal, instead of the coke of the bituminous veins, upon the whole of the blast-furnaces which I at present have (three in number) at the Yniscedwin Iron Works: that I have renewed all my mineral takings in the anthracite part of the basin for ninety-nine years, and that I have arrangements in contemplation for a large extension of the works, in consequence of the perfect success which has resulted from the experiment.

One of the three furnaces at present on my establishment, is a small cupola furnace, which we call No. 2, built from the top of the hearth with firebricks only; this cupola is of the following dimensions:—Forty-one feet in its whole height; ten feet and a half across the boshes, and the walls of the thickness of two nine-inch bricks; the hearth three feet six inches square, and five feet deep. The two other furnaces, which we call No. 1 and No. 3, are thick stone-walled furnaces. Some years since I found that this cupola furnace, No. 2, had, on the average of a long period (I concluded from the smallness of its dimensions and the thickness of its walls), taken so large an excess of minerals to the ton of iron produced, when compared with the quantity taken on the average of the same period by the stone-walled furnace, No. 1, standing within fifty feet of it, that I determined to erect a second furnace, similar to the latter one, in lieu of it.

The meeting will shortly understand why I am giving these details, which may at the moment appear not to be very interesting particulars. This cupola furnace, No. 2, not being at work when I arrived at the determination to try the experiment of the combination of hot-blast and anthracite coal upon the large scale, it was more convenient to put this furnace into blast for the purpose, rather than to interfere with the usual progress of my business by experimentalizing in either of the two other furnaces. The cupola furnace, No. 2, from the causes which I have before explained, had on the average of a long period taken cokes, the produce of five tons and three cwt. of coal to the ton of pig-iron, when the stone-walled furnaces had not required cokes to the ton of metal, produced quite equal to four tons of coal. The consumption of ironstone and limestone had been greater in the former than in the latter description of furnace, but not to so great an extent.

I will make one other explanatory remark on this part of the subject. The two descriptions of furnaces have worked in so different a manner with the minerals of my neighbourhood, that whilst the barrow of cokes, weighing about three and a half cwt., would take when consumed in either of the stone-walled furnaces a charge or burden of five to five and a half cwt. of calcined iron mine, of the descriptions obtained in my neighbourhood, according to the kind of iron which I was desirous of producing, the same barrow of cokes in the No. 2 cupola, or thin-walled furnace, would only carry from three to three and a half cwt. of calcined mine of the same kind. Under these disadvantageous circumstances, I have actually produced from the No. 2 cupola furnace the ton of iron in the smelting process, on the average of three months, with less than twenty-seven cwt. of anthracite coal. The heating of the blast, and the calcination of the mine require, of course, upon my plan, the same quantity of fuel, which is necessary for the like processes in other establishments.

With regard to the quantity of iron produced, the result which I have to report is equally satisfactory. I must not, however, omit to mention that for the greater convenience of filling this cupola furnace, No. 2, from an adjacent gallery, previous to the commencement of my anthracite experiments, I raised it in height from thirty-six feet six inches to forty one feet; this might have had *some* effect upon reducing the excess of the consumption of fuel when compared with that which had taken place in the No. 1, and might have increased its power of smelting with my blast of one-quarter pound upon the square inch pressure, only from its former average of twenty-two tons to twenty-four. Since I have adopted the use of anthracite coal combined with hot air, my make in the No. 2 cupola furnace, with the same pressure of blast only, has ranged from thirty to thirty-four and thirty-six tons, and one week we actually tapped within three cwt. of thirty-nine tons of grey iron from this furnace; its present weekly average may be expected to range from thirty-five to thirty-six tons.

With respect to the quality of the iron produced by the combination of hot-blast and anthracite coal, the result which I have to communicate will be very satisfactory; it is well-known in my neighbourhood that my cold blast iron for all purposes, where great strength was required, was never deemed inferior to any smelted in South Wales; that which I have hitherto produced with hot-blast and anthracite coal is, however, decidedly stronger than any other before smelted at the Yniscedwin Iron Works.

Relying upon the representations of chemists, that anthracite coal is almost entirely composed of pure carbon, I have always indulged the hope, that in the event of my ever succeeding in discovering a method of applying this fuel to smelting purposes, that I should be able to produce a quality of iron not very dissimilar to that formerly obtained by smelting with charcoal; how far this expectation will be realised further experience must prove, but, as far as my experience of the quality of this particular description of iron up to the present time has gone, I am sanguine with respect to the result. I shall be happy at any time to offer every facility in my power to any parties who may be deputed by this Association, or by any other scientific body, to thoroughly investigate this important subject.

If I have not trespassed already too long upon the time of the Section, its members may not be uninterested in being informed in what manner the idea first occurred to me of applying an heated blast to anthracite coal. One evening, after I had placed a piece of it upon my parlour fire (which had before been made up with bituminous coal), and had allowed it to arrive at a red heat, upon my applying as fierce a blast to this piece of coal as I could raise from a pair of bellows, I noticed the appearance of a black mark or spot upon that part of it where the air infringed upon it; on my continuing the like rapid current, in the same direction, I shortly blew the fire out of it. I at once perceived that the effect of the strength of the current of air, when cold, which we of necessity are obliged to blow into our furnaces to secure the passage of the blast through the high and dense column of materials contained in an erection like a blast-furnace, instead of encouraging ignition, was actually unfavourable to it. On giving the thing but a moment's reflection, the question promptly occurred to me, What would be the effect of turning a blast into a furnace upon this coal, which would itself burn—which would itself melt lead? I at once determined that it was a thought which was really worthy of nature reflection. The further consideration which I gave to the matter, and the further experiments which I shortly afterwards instituted (which were continued at a great expense for some months), have at length been crowned with the full success which I have now had the pleasure of reporting to this meeting.

The anthracite formation probably occupies about one-third of the Mineral Basin of South Wales; it commences near the upper part of the vale of Neath, in the county of Glamorgan, and proceeds in a westwardly direction through the remainder of that county, thence through that of Carmarthen, and crops out (as I am informed) in the sea, in St. Budes Bay, after passing through a considerable portion of the county of Pembroke. It is likewise to be found in France, Austria, Bohemia and Sardinia, in the Old World, and very large deposits of it have been already discovered on the continent of America, particularly in the State of Pennsylvania.

At the meeting of the Section of Chemistry and Mineralogy, on Thursday, Dr. Thomas Thomson read a report "On the Comparative Composition of Cast-iron prepared with the hot and the cold-blast."

Dr. Thomson observed, that the specimens of cast-iron examined were all from iron smelted from the ironstone in the Glasgow coal-field. This ironstone is a carbonate of iron, more or less pure. The richest is known by the name of *Mushet's black band*, which occurs in the neighbourhood of Airdrie; its specific gravity is 3.0553, and it is composed of

Carbonate of iron	85.44
—— of lime	5.94
—— of magnesia	3.71
Silica	1.40
Alumina	0.63
Peroxide of iron	0.23
Coal	3.03
	100.38

In the poorest specimens of ironstone the carbonate of iron amounts to only 29 per cent., but such specimens are rejected by the iron masters. The ore is roasted, to drive off the carbonic acid; this, at an average, reduces the weight about 31 per cent.; it is then mixed with limestone and coal, and smelted.

When the Clyde iron works were established, above forty years ago, ten tons of coal were requisite to produce one ton of iron. This coal was previously coked, by which rather more than half its weight was driven off under the form of gas, &c. By various improvements the quantity of coal requisite was diminished from ten tons to seven tons thirteen cwt., and the quantity of limestone requisite for smelting one ton of iron was ten and a half cwt. When hot air (or air heated to above 607 degrees) was blown into the furnace instead of cold air, it was found that coal could be used without being coked, and the quantity requisite to smelt a ton of iron was reduced to two tons nineteen cwt.; the lime was reduced to seven cwt., and the produce of iron in a given time from a furnace was more than doubled. The reason of this superiority of hot air over cold seems to be, that when the hot air enters the furnace it is immediately united to the coal, and is all consumed; whereas, the cold air partly passes up through the materials, and produces, as it ascends, a scattered and useless combustion. Hence, when hot air is introduced, the heat at the point of combustion is greater than when cold air is used. Hence, the smaller quantity of limestone requisite, and the greater produce in iron in a given time. The specific gravity of cold-blast iron is lower than that of hot-blast. The average of the former being 6.7034, and that of the latter 7.0623.

The following table shows the composition of six specimens of cold-blast iron from different localities:—

	Muirkirk.	Ditto.	Ditto.	Pyrites	Carron	Clyde.	Mean.
Iron	90.98	90.29	91.38	89.442	94.010	90.824	91.154
Copper				0.288			
Manganese		7.14	2.00		0.626	2.458	2.037
Sulphur						0.045	
Carbon	7.40	1.706	4.88	3.600	3.086	2.458	3.855
Silicon	0.46	0.830	1.10	3.220	1.006	0.450	1.177
Aluminum	0.48	0.016		3.776	1.022	4.602	1.651
Calcium		0.018	0.20				
Magnesium						0.340	

The constant constituents were iron, carbon, silicon, and aluminum; and manganese was a pretty frequent ingredient. The average proportions were

3½ atoms of iron and manganese.
1 —— of carbon, silicon, and aluminum.

The atomic proportions of the carbon, silicon, and aluminum, were 4, 1, 1, so that cold-blast cast-iron may be considered as composed of

21 atoms iron and manganese.
4 —— carbon.
1 —— silicon.
1 —— aluminum.

The following table exhibits the composition of hot-blast cast-iron, No. 1:—

	Clyde.	Carron	Carron	Clyde.	Clyde.	Mean.
Iron	97.096	95.422	96.09	94.966	94.345	95.58
Manganese	0.332	0.336	0.41	0.160	3.120	0.87
Carbon	2.460	2.400	2.48	1.560	1.416	2.099
Silicon	0.280	1.820	1.49	1.322	0.520	1.086
Aluminum	0.385	0.488	0.26	1.374	0.599	0.422
Magnesium				0.792		

These constituents are in the proportion of

6½ atoms iron and manganese.
1 —— carbon, silicon, and aluminum.

In the cold-blast we have

Iron.		Carbon, &c.
3½ atoms	+	1 atom.

In the hot-blast

6½ atoms	+	1 atom.

Thus, it appears, that hot-blast iron contains only about half the foreign matter that exists in cold-blast iron.

Cast steel, made from the best Dannemora iron, had a specific gravity of 7.8125. Its constituents were—

Iron	99.288
Manganese	0.190
Carbon	0.388
	99.866

Or it contained

55.7 atoms iron
1 atom carbon.

In reply to questions, Dr. Thomson stated, that he had made no experiments on the comparative composition of bar-iron from pigs made with the cold and hot-blast, and that he had not found any phosphorus in the specimens of cast-iron whose analysis he had detailed.—Mr. Tennant stated, that the bar-iron by the hot-blast was equally tough, both hot and cold.—Mr. Guest inquired of Mr. Tennant, whether in the puddling, hot-blast iron did not lose more than the cold-blast iron: but to this no satisfactory answer was given.—Dr. Clarke contended, that as the impurities of cold-blast iron are about double those of hot-blast iron, it was impossible that, as suggested by Mr. Guest, this latter should undergo a greater waste in the process of refining. If such should be proved, he would consider it a chemical miracle. In continuation, Dr. Clarke observed, that manufacturers were too much in the habit of working by what he called the "rule of thumb," and that, in particular, as the difference of the quantity of pig-iron depended materially upon the heat employed, by not attending to this essential condition, iron masters were liable to fall into erroneous conclusions as to the value of any particular improvement. Mr. Guest being called on by the President to speak to this point, stated distinctly, that he found the hot-blast iron to lose more in puddling than the cold; and he had the impression that it was of inferior quality.—Dr. Thomson asked, whether the iron referred to by Mr. Guest was, or was not, made from cinder, to which Mr. Guest replied, that in some cases it was, but that his observation in reference to the greater loss experienced by hot-blast iron in the refining surface was applicable to varieties in the manufacture of which cinder was not employed.—Professor Johnston expressed his surprise at the absence of phosphoric acid from the Glasgow iron, the more especially, as in the Newcastle coal-field phosphoric acid is

bundant, and the nodules of clay ironstone, which may be considered as coprolites, always, as is well-known, include phosphoric acid. He also stated, that as specimens of hot and cold iron have frequently the same physical properties, it is very difficult to pronounce upon the relative value of these processes. The white and black cast-iron also may have the very same composition, and therefore the quality of iron must be referred to something totally extraneous to chemical constitution. In fact, quick or slow cooling will determine the pig to be of the one or the other colour. The President observed, that though, generally speaking, black iron may be considered as yielding the best malleable iron, this could not, with any probability, be predicated of black cast-iron got by the rapid cooling of the white variety, as suggested by Professor Johnston.—Dr. Thomson stated, that cinder is a mixture of silicates of iron; and, subsequently, expressed his conviction that the quality of iron, notwithstanding what had been alleged to the contrary, is chiefly dependent on its composition, and that if phosphorus, for example, or sulphur, were present, the metal could not be good. The same gentleman, in conclusion, decried the doctrine, which would place what was called the "rule of thumb" above what he considered a much more valuable guide—the Rule of Science.

We copy the following remarks from the *Merthyr and Cardiff Chronicle*; they are given by a correspondent of that paper, at the conclusion of a report of the above proceedings:—

It will be observed, that three results were obtained for this investigation. 1st. That from a comparison of the tables, it will be seen that the quantity of iron in the hot-blast specimen, was 5 per cent. more than in the cold-blast. 2d. The extraordinary fact, that in no case was there any trace of phosphoric acid; and, 3d. That iron from the same materials, by both processes, broke with the same weight. But is this a fair comparison? I should say certainly not. To my mind, and, I believe, to the minds of most persons present, it was anything but satisfactory. The learned Doctor professed to give "a comparative analysis of iron in the different stages of its manufacture with the hot and cold-blast;" but was such the case? By no means; there were no chain cables produced, made from cold-blast iron; nothing more than the small bar alluded to, therefore the comparison could not be borne out. We are most undoubtedly indebted to Dr. Thomson for his beautiful analysis of the Scotch iron, and for his general description of the advantages in saving fuel by the hot-blast, but much remains to be done ere we get a fair estimate of the qualities of the descriptions of iron. I mean no offence to the learned Professor when I name it, but the whole matter appeared to me to be a description of the value of Scotch hot-blast iron, rather than an impartial comparison of the relative merits of metal smelted from two particular processes.

I cannot close this hasty communication without alluding to the suggestion of Dr. Johnston, that the presence of phosphoric acid, in the English coal-fields, may be done to the existence of extensive layers of coprolites. This may be true, as far as Newcastle is concerned, but surely it cannot extend to coal-fields, where the ore is composed of regular strata of clay, ironstone, and where coprolites are but seldom found. I beg to inclose you also Mr. Fairburn's statement of his experiments on hot and cold-blast iron made to the Mechanical Section on Tuesday, by which it will be seen that the result is in favour of hot-blast iron.

At the meeting of the Mechanical Section on Tuesday, the comparative strength and other properties of the "hot-blast iron" were reported upon and discussed at considerable length. The subject was introduced by Mr. Fairburn, who read the report, which he had prepared from numerous observations and experiments on the subject, which had been made by him at the request of the Association, during the last twelve months:—

At a previous meeting of the Association, Mr. Hodgkinson had communicated a Report on the comparative strength and other properties of iron manufactured by the hot and cold-blast.—In the prosecution of inquiries since made, it was conceived desirable to subject the metals operated upon to more than one species of strain; to vary their forms, and, by a series of changes, to elicit their peculiar, as well as comparative properties. First, they have been drawn asunder by direct tension. Secondly, they have been crushed by direct compression, both in short and long specimens (the results of which will be given in a paper read on Thursday); and, Thirdly, they have been subjected to fracture by transverse strain, under various forms of section, and at various temperatures. Ten bars of hot and cold-blast iron were also loaded with different weights, from 112 lbs. to near the breaking point, and left for many months to sustain the load, and to determine the length of time necessary to effect the fracture. The bars thus loaded, are still (with one exception) bearing the weight, having been suspended upwards of six months, and, from what we can at present perceive, there is every chance of a long and protracted experiment. In making the experiment on transverse strain, a number of models, of different sizes and forms were prepared, and the irons, both hot and cold-blast, were run into the form of these models; but as there is usually a slight deviation in the size of the castings from that of the model, the dimensions of the bars were accurately measured at the place of fracture, and the results reduced, by calculation, to what they would have been if they had been cast the exact size of the model, assuming the strength of rectangular beams to be as the breadth and square of the depth, and the ultimate deflection to be inversely as the depth, the length being constant. In comparing two irons, the greatest care was taken to subject them as nearly as possible to the same treatment.

A series of experiments was also made to determine the strength of hot and cold-blast iron at various temperatures, from thirty-two degrees (the freezing point) to the boiling point; for this purpose, a cast-iron trough was employed, in which the bars to be broken were placed, and covered with snow or water (which was kept at the proper temperature by a jet of steam), as the case required; the weights were then gradually laid on until fracture took place.

The strength of bars made red hot was also tried, and, contrary to expectation, they retained their tenacity and power to resist the load to a considerable extent: the reduction of strength in a bar one inch square, in a range of temperature from thirty-two degrees to that of redness was rather more than one-sixth, the deflection being upwards of one and a half inch in a bar two feet three inches long.

RESULTS.

Carron Iron No. 2. (Scotch).

Mean ratio of transverse strength, assuming the cold-blast iron at .. .. 1,000 : 9,799
Mean ratio of power to resist impact .. .. .. 1,000 : 1,038.9

Whence in the transverse strength of Carron iron No. 2, using a variety of forms of section, the strength of the cold-blast is to that of the hot-blast, as 100 to 98, nearly.

Devon iron, No. 3.

Mean ratio of strength in sections of various forms (thirteen experiments) .. .. 1000 : 1409
Power to sustain impact .. .. 1000 : 2742

This is an exceedingly hard iron, with a singular appearance, the centre or more granulated parts of the fracture being surrounded with a circle having the appearance of hardened steel.

Buffery, No. 1, Staffordshire iron cold and hot-blast.

Mean ratio of breaking weight .. .. .. 1000 : 925
Mean ratio of power to resist impact .. .. .. 1000 : 965

In the buffery iron, the hot-blast manufacture is weaker whether we view it in its transverse strength, or its power to resist impact.

Coed Talon, No. 2, North Welsh iron.

Mean ratio of strength in a number of experiments .. 1000 : 1014
Mean ratio of power to resist impact .. .. .. 1000 : 1219

Modulus of elasticity in lbs. for a bar of one inch square.

Cold-blast $\left\{\begin{matrix}14,680,000\\13,947,000\end{matrix}\right\}$ 14,313,500 lbs.

Hot-blast $\left\{\begin{matrix}15,810,000\\12,835,000\end{matrix}\right\}$ 14,322,500 lbs.

Elslear Cold-blast, No. 1, against Melton Hot-blast, No. 1 (Yorkshire Iron).

Mean ratio of strength .. .. 1000 : 809
Mean ratio of power to resist impact .. .. 1000 : 858

The modulus of elasticity in all the irons are computed; but only given in a few cases in the results.

Relative strength of hot and cold-blast iron to resist a transverse strain at different degrees of temperature.

Cold-blast 949.6 at thirty-two degrees. Hot ditto 919.7, Mean.
Ratio of strength, 1,000 : 977.6.
Power to resist impact, 1,000 : 1,039.
Cold-blast 748.1 at 191 degrees. Hot ditto 823.6.

In these experiments, it appeared, that the cold-blast lost in strength from 32 degrees up to a blood red, perceptible in the dark as 949.6 to 732.1; whereas, in the hot-blast the strength is not so much impaired, being as 917.7 at the freezing point, and 829.7 when perceptibly red in the dark.

In all former experiments on the transverse strain of cast-iron, it has been assumed, that the elasticity remained perfect up to one-third the breaking weight. In pursuing these experiments, discrepancies were noticed, and results widely different to those generally received were observed. It was found that one seventh, and, in some cases, one-eighth the breaking weight was sufficient to produce a permanent set. These facts induced an extended series of experiments, principally to determine what load was necessary to effect a permanent set; and, if such weight, continued for an indefinite time, would break the bar. It became a question of great importance to know, if a weight, having once impaired the elasticity, would or would not, if continued, increase the deflection. The inquiry, therefore, was—To what extent can cast-iron be loaded without endangering its security? To solve this question, ten bars of hot and cold-blast, differently loaded, were placed upon a frame, to ascertain the amount of deflection at stated periods, and to determine what was necessary to break the bars with their respective loads.

	Inches.
In the cold-blast, with a load of 280 lbs., the deflection increased in 103 days from	1.025 to 1.033
Hot-blast, ditto from	1.173 to 1.197
Cold-blast, with a load of 336 lbs., increased in 105 days, from	1.334 to 1.366
Hot, ditto, from	1.573 to 1.627
Cold, with a load of 392 lbs., increased the deflection in 108 days, from	1.786 to 1.843
Hot, ditto, from	1.891 to 1.966

Cold-blast, with a load of 448 lbs., continued to increase in deflection, and ultimately broke, after sustaining the weight thirty-five days. All the bars from the hot-blast broke in the act of loading them with the above weight, 448 lbs.

Mr. Fairburn stated, that all the irons were made of the same materials, and under the same circumstances. The irons were of fifty sorts.

Mr. Cottam inquired as to the elastic forces. Dr. Young and Mr. Tredgold had found that the strength of the material would fail if loaded beyond its elastic force: he wished to know whether the loads had been more or less than 850 lbs. to the foot. Mr. Fairburn stated that some of the loads were more, some less, and that a weight of 280 lbs. produced a permanent set of an inch square bar. The President remarked, that the calculation as to elastic forces was scarcely to be confided in. Mr. Fairburn, in answer to another question, stated, that the hot-blast iron was the more flexible and better capable of bearing impact; but that all the results of impact had been taken from calculations founded on cold-blast iron. Mr. Fairburn stated, that the crystalline appearance was finer in hot than in cold-blast. There were no experiments made on the loss by remelting, and none on wrought-iron—all on cast-iron. In reply to Mr. Cottam, he mentioned, that all the Scotch irons had no cinder; the composition of the others they did not know. Great difficulty had been experienced on this point, because the different manufacturers were unwilling to give information.—Mr. Guest professed on his part the fullest readiness.—Some conversation took place with regard to the peculiarity of appearance in the broken bars. The President remarked, that when a rectangular bar of any substance is exposed either to fracture, or even to temporary deflexion, a similar appearance was found: this was known from the experiments on glass, by polarized light. Mr. Fairburn in assent said the crystals were always more compact in the edge than the centre. Mr. Webster inquired whether the elastic weight was always less than one-third of the breaking weight. Mr. Fairburn said, always—and afterwards replied to a question from Mr. Guest, that the Scotch hot-blast iron showed a greater comparative strength as compared with cold-blast, but that they had made no experiments on South Welsh iron. There was a perceptible permanent set from 280 lbs., the experiments being of from five to ten minutes in duration, and it being possible to judge the deflexion to the 1000th part of an inch.—Mr. Webster said it had been found that the first set was owing to the breaking of the first crust, and that beyond the first permanent set up to the elastic limit, the deflexion increases exactly as the weight. Some further conversation ensued, in which Mr. Smith and others took part, when Mr. Guest suggested the propriety of further continuing these researches, to which the President agreed, and suggested a recommendation to this effect from the committee of the section to the general committee. Thanks were then voted to Mr. Fairburn for the zeal and skill with which he had prosecuted these researches for the Association.

In the Mechanical Section on Thursday, the consideration of the comparative strength and other properties of hot and cold-blast iron, was resumed by Mr. Fairburn, who read a paper on that subject, being a continuation of the former paper read on Tuesday, from Mr. Hodgkinson's experiments.

The examination of the relative properties of hot and cold-blast iron required that experiments should be made, in which the material was subjected to every description of strain. Leaving the power of adapting the experiments to the determination of some few questions of a more general nature; such, for instance, as the following:—The proportionality of the resistance to crushing, to the area of section—The decrease of strength to resist crushing in long specimens, compared with those in short—The influence of form of section in resisting transverse strain—The strength of beams of best form compared with that of the rectangular. These questions, which have not been satisfactorily determined, have had considerable attention paid to them.

In order to ascertain the degree of accuracy of the admitted fact, that the strengths of rectangular beams are to each other as the square of the depth, castings were formed, one inch, three inches, and five inches in depth, and all of the same breadth and length; it is evident, then, that if the strength of each beam is divided by the square of its depth, the quotient should be the same quantity in each. On performing this operation, we have—

In hot-blast Carron iron	428.5	427.	402.12
In cold-blast, ditto	445.8	416.7	414.5
Mean	437.1	421.8	408.8

These numbers, taking the mean, are as nearly equal as perhaps may be expected in such a case; we may therefore admit that the strength is as the square of the depth.

Compression.—In the fracture of bodies by crushing, there are three modes in some degree different from each other. For instance, when a cylinder of cast-iron, whose length is several times its diameter, has a force applied to crush it, fracture will take place by the cylinder being broken straight across as if the force had been applied transversely. If the length is small, fracture will usually take place by a wedge sliding off, the height of the wedge being about one and a half the diameter.

The strength of a cylinder is of the same quantity, provided the length is not less than one and a half, nor greater than about three times the diameter. If the length of a cylinder is somewhat shorter than one half its diameter, it will give way by the separation of a wedge whose vertex is bruised; and if much shorter it will be crushed by the cylinder showing one or two cones whose bases are the ends of the cylinders, the truncated vertex of one cone splitting the base of the other. It is this tendency of crushed bodies to form two opposite cones, that causes cylinders or prisms to be bulged out in the middle before fracture.

The results of a great number of experiments, when reduced to one common denominator (one inch square), were nearly equal in the first (cold-blast) iron, and not very different in the other. In the latter iron they were

	lbs.	lbs.		
Cold-blast	124023	128478	123708	
Hot ditto.....	130909	131665	112605	111557

In the former, or cold-blast iron, the area of the last specimen was to that of the first, as four to one, and in the hot-blast the areas were as 6.55 to 1.

GENERAL SUMMARY.

Strength of the different irons.

Carron Iron, No. 2.

Mean ratio of transverse strength of cold-blast iron to that of hot .. .. 1000 : 979.9
Mean ratio of cold-blast bars to those of hot to bear impact .. .. 1000 : 1038.9

	Cold-blast.	Hot-blast.
Tensile strength per square inch in cold and hot-blast iron	lbs.	lbs. 13892
Compressive strength per square inch in each of the irons	100631	98125

Ratio of compressive to tensile force.—
(In cold-blast iron this experiment was lost).

$$\text{In hot-blast, } \frac{98125}{13892} = 7.06342$$

rather more than 7 to 1.

The transverse strains, force of impact, &c., having been given in a previous Report, will be omitted in the following irons.

Devon Iron, No. 3.

	Cold-blast.	Hot-blast.
Tensile strength per square inch	———	21907
Compressive strength, ditto	———	145435

Ratio of compressive to tensile force:—

$$\text{In cold-blast, } \frac{\text{———}}{145435}$$

$$\text{In hot-blast, } \frac{\text{———}}{21907} = 6.638$$

Buffing Iron, No. 1.

	Cold-blast. lbs.	Hot-blast. lbs.
Tensile strength, per square inch, in each of the irons ..	17466	13434
Compressive strength per square inch	93366	86397

Ratio of the compressive to the tensile force:—

$$\text{In cold-blast iron, } \frac{93366}{17466} = 5.346$$

$$\text{In hot-blast iron, } \frac{86397}{13434} = 6.431$$

Coed Talon, No. 2.

	Cold-blast. lbs.	Hot-blast. lbs.
Tensile strength, per square inch, in cold and hot-blast irons	18855	16676
Compressive strength, per square inch, in each of the irons	81770	82734

Ratio of compressive to tensile force:—

$$\text{In cold-blast iron, } \frac{81770}{18855} = 4.337$$

$$\text{In hot-blast iron, } \frac{82734}{16676} = 4.961$$

At the meeting of the Mechanical Section on Wednesday, but few subjects were brought forward that were likely to interest our readers; we may, however, select the following:—

Mr. Mushet made some observations on railway iron, founded on experiments carried on for forty years. He expressed himself much surprised, that hitherto, in contracts for iron for railway purposes, fibre and hardness were not stipulated for, but were left to the chapter of accidents. Both these qualities might be attained by his method, the principal characteristic of which consisted in doing away with the refining process now in general practice, and the preventing the severe decarbonization to which the iron was at present exposed. Several specimens of iron, of extremely fine fibre and hardness, were laid before the Section, and afterwards removed to the Model Room. The great object of his process was, to obviate the evil of lamination. On some railroads they had been obliged to lay the iron two or three times; but he had little doubt, that it would soon be possible to obtain a solid rail without any exfoliation.

Mr. Cottam mentioned, that he had known a piece of iron six inches thick, and considerably bent, to be quite straightened by blows, but, at the same time, to be greatly weakened; and that he attributed this to some of its constituent crystals being driven into it by the force of the blows, like so many wedges, thereby weakening the strength of the iron.

We extract the following information relative to the construction of magnets and the magnetic properties of iron and steel of different kinds, from the proceedings of the Mathematical and Physical Section:—

The Secretary next read a communication, forwarded to the Association by N. L. Beamish, Esq., "On an improved mode of constructing Magnets," by Mr. Cunningham, of Cork. The author stated, that as a cheap method of making magnets had now become a subject of deep importance and very general interest, chiefly as related to their use in magneto-electrical machines, and having some time since turned his attention to the subject, he had tried steel of various qualities, but could not succeed in making magnets sufficiently powerful for the above purposes. While thus engaged, he met with a communication from Mr. Knight, jun., to the Society for the Encouragement of Arts, published in their fiftieth volume, describing a new mode of construction, and recommending common blister steel of an open grain and highly carbonized, as the best material for the purpose; and since much hammering is highly injurious, he advised that the steel should be procured of the size exactly suited to the required magnets, which would obviate the necessity of forging, except at the centre of the rod, to give it the horse-shoe form. The author stated, that it would be an obvious improvement upon this method, to give iron the required form previous to its conversion into steel, as this would render any further disturbance unnecessary. It occurred to him, while reflecting upon the very large quantity of carbon in cast-iron, that it ought to be admirably adapted to this purpose, and, in order to test the correctness of his opinion, he got three small castings made of the horse-shoe form, each weighing seven ounces; on touching these with a small compound magnet in the usual manner, he was very agreeably surprised to find them absorb and retain the magnetic influence in a degree superior to any steel ones he had ever previously constructed; and stated, that he had no doubt that they would be further improved if beaten red-hot, and very slowly cooled, which would make the metal softer, and the grain more uniform, and they might afterwards be hardened at the poles to produce the maximum effect. He considered this result of much importance, as it will enable us to construct compound magnets for magneto-electrical machines with great facility, and at a very trifling expense, as any number can be cast from one timber pattern.

Mr. Christie stated his regret that the gentleman, whose communication had been just read, had not entered into numerical details, stating as well the power of the steel magnets which he had previously made, as the actual and comparative power of the cast-iron magnets, which he seemed so much to prefer. It must be obvious, that without this information, no scientific person could at all confide in the vague statement, that magnets made in one particular way were superior to those made in another way, for both might be badly made, and the difference might not be of much practical importance. He strongly doubted the value of cast-iron as a material for the construction of magnets.—Mr. Holden said, that he had bestowed much time and attention on the construction of magnets. He preferred steel tempered blue, or to spring temper, and was, on the whole, inclined to agree with the last speaker, in doubting the value of the material proposed. He knew that cast-iron was capable of receiving strongly the magnetic influence, and bars of cast-iron, as long as they retained their upright position, were found to possess polarity in a very high degree; but he doubted whether, if they were removed from their upright positions, they would long retain their polarity to any considerable extent.—Mr. Peacock fully agreed with Mr. Christie, that the information conveyed in this paper was of too vague a character to be much depended on, or to be of much practical benefit: there were, however, so many individuals engaged in these investigations that he did not doubt but that very soon the materials best suited to the construction of magnets would be decided on, if, indeed, that had not been already done.—Mr. Christie stated, that, at the very last meeting of the Association, in Bristol, the Rev. Mr. Scoresby had made a communication respecting the construction of magnets, and the material he preferred was very evenly-tempered steel, of the blue temper, such as watch springs, or ladies' busks. He had also strongly reprobated the leaving any part of a magnet soft, and hardening the rest.—Mr. Stevelly begged leave to ask Mr. Christie, or Professor Lloyd, whether Captain Kater had not, in his extensive experiments, examined cast-iron as one of the materials fitted for the construction of magnets; for if so, he, of course, had stated the comparative merits numerically, his object being to determine the best material for the construction of compass-needles.—Mr. Christie replied, he did not remember whether Captain Kater included cast-iron or not, in his very extensive and valuable series of experiments; but of one thing he felt certain, that he had not recommended it as the best material.—Mr. Snow Harris observed, that, from many trials, and much experience, he was convinced that hardened steel wire, just as it is to be had in the shops, without any further working it, or putting it into the fire, or altering its temper, was the best material for constructing small needles, intended to retain their magnetism permanently; and this latter consideration was of the utmost consequence when constructing needles for philosophic research—as, for instance, upon the magnetic intensity at various places, since the slightest alteration of power, in that case, would most materially and injuriously affect the result.—Professor Henry had tried cast-iron, and had found that it did not retain its magnetic power so effectually as common steel.

We have now extracted from the proceedings of the late meeting all that relates to the important process of the iron manufacture, together with some other incidental information on the properties of that metal, being all that we propose doing on the present occasion. In our next Supplement the report will be concluded, by a similar abstract of the papers read before the Geological Section, together with such other miscellaneous matter from the other Sections as may be suitable for the columns of our Journal.

PROGRESS OF SCIENCE.—A report of the Natural History Society of Montreal has recently been published. The Society has purchased a house for the uses of the Society; they have made extensive efforts towards the attainment of a correct knowledge of the meteorology of British North America; they urge a geological survey of the provinces of Upper and Lower Canada; lectures had increased, a taste for science was progressing, and the Society generally appeared to be in a prosperous condition.

MAMMALIA.—The remains of Mammalia have been found on the plains of Cheshire. In the progress of cutting for the Grand Junction Railway, two grinders of the elephant were discovered in a bed of gravel replete with marine shells.

MINING JOURNAL

ORIGINAL CORRESPONDENCE.

HOT-BLAST.

TO THE EDITOR OF THE MINING JOURNAL.

SIR,—Since my last letter addressed to you on the subject of iron produced with heated air, I have had an opportunity of fairly trying the comparative value of hot and cold-blast pigs, for the purpose of being converted into bar-iron, the result of which fully confirms the opinion I have before expressed, as arising from my own observation on such pig-iron, and from information received from other parties.

The experiment also tends to show that whatever may have been the result of the trials hitherto made on the strength of No. 3 hot-blast pig-iron, which have been stated to have been much in favour of the new process, it does not apply to the manufacturing or conversion of the pig into malleable iron. The quantity I experimented upon was nearly twenty tons—a quantity sufficient to afford ample proof of any good or bad property inherent in it. The pigs were No. 3, of very excellent apparent quality, smelted with cokes, and from very superior ironstone such as might have been expected to have produced iron of the very best quality; and every possible care and attention was paid to the different converting processes through which it passed. To enable me to make a comparative estimate of the value of each, I worked a quantity of cold-blast pigs of as near the same quality as I could select, and the same care and attention was paid to the manufacturing this lot as to the other; and for the purpose of conducting the experiment with as much impartiality as possible, the same workmen were employed throughout. In the first process, or that technically termed "refining," there was a marked difference in the working of each. The cold-blast pigs produced what the workmen term, a good kind cinder—the hot-blast pigs, on the contrary, produced rather a tough tenacious cinder, which as the blast passed through, it was blown through the fire in bubbles, producing an appearance similar to fermentation. This arises from its enclosing and retaining for a time a portion of air, which forms cells giving it this appearance. This takes place at times with the very best iron, arising from temporary and accidental causes, which admit of ready explanation, but which will take up too much time and space to enter upon at present. This is, however, by no means a general occurrence as it was with the whole of this iron, and was, there is no doubt on my mind, a natural result of the earthy matter which was in combination with the pigs in a metallic state, being oxidised by the action of the blast, and thereby separated from the iron, and thus combining with the cinder, which consists principally of oxide of iron, gave it the appearance I have just described. It may be supposed by those unacquainted with the process, that the small quantity of silex thus set at liberty could not have this effect; but when it is stated that the quantity of iron melted at one charge is at least thirty-five hundred weight, it will be seen that if only three per cent. becomes separated, it will amount to 120*l.*—a quantity fully sufficient to account for the change in the cinder.

In the puddling process the difference was much more marked, as coming more immediately under direct observation, than in the refinery. In this stage the iron first becomes malleable, and the quality becomes quite apparent—in short, a person possessed of some little experience cannot be deceived here. Pure malleable iron, as is well known, is exceedingly infusible, and requires a most intense heat to melt it; but in proportion as it becomes alloyed with other metals its fusibility increases, and there are some descriptions which melt at a comparatively low temperature, as is well known to smiths, who are occasionally much annoyed by finding their iron "burnt," as they term it. These several kinds of iron have very different affinities for oxygen under similar temperatures, and also very different capacities for heat; comparatively pure iron, when submitted to intense heat in the furnace, preserves a bright yellow colour. A current of air passing over it, has, of course, considerable action on it, gradually reducing it to the state of oxide, but there is no appearance of fusion. Place a similar piece of what I shall term alloyed iron, along side of it, and it will be found that this assumes a very different appearance—instead of the yellow colour which the other maintains, this will be found under the same temperature to become intensely white and bright—in a state of semi-fusion—and a current of air passing over it, acts most violently upon it, the oxide running down from it in small streams, and unless the greatest care is taken by the puddler, the waste on such iron will be enormous; whilst, comparatively speaking, under similar circumstances, the other will waste but little. This description applies strictly to the cold and hot-blast iron above referred to—the former having been what the workmen term "good strong iron, which will stand as much heat as we can give it, and give us plenty of yield"—whilst the latter, they describe as being "tender rotten stuff, which will not stand fire, and will give us no yield." The term "yield" is made use of to signify the produce from a given quantity of iron—the difference, of course, shows the waste.

The same discrepance in the affinity of each for oxygen was apparent in the re-heating furnaces, where the piles are heated, preparatory to their being rolled into bars, in the rolling-mill. From the remarks made, it will be concluded that greater waste has taken place in manufacturing the hot than the cold-blast pigs—this is the case, and to a serious extent, the excess amounting to 1 cwt. 2 qrs. 7 lbs. of pigs, per ton of No. 2 bars, the value of which is of more importance than any advantage which will in a general way be derived from its use, and this, independent of the deterioration in the quality of the iron produced.

In my first letter, I mentioned my having been informed that the iron smelted at Merthyr with hot-blast, produced bars of excessive cold-short quality—my informant still assures me this fact. I however did not find it to be the case here, for both the puddled and finished bar broke tough and fibrous, but possessing that peculiar dull earthy appearance, which it is difficult to describe, but is well-known to all who have been in the practice of attending to the fracture of various kinds of iron; it was also perfectly ductile and malleable, and no doubt well adapted for any light work not requiring strength—but where this is necessary I am afraid it will be found wanting—indeed, as far as my experience goes, I am quite satisfied of it, and the following result of a trial of its strength will prove that I am justified in arriving at this conclusion. Both descriptions of iron were rolled into rounds of one and one-eight of an inch in diameter, which is as near as possible, equal in sectional area to one inch square; at the end of this you have a copy of a certificate from Mr. Tombs, chain cable manufacturer, at Newport, which shows the one and one-eighth-round hot-blast iron broke under an average strain of twenty and a half tons, and the same size cold-blast iron broke under an average strain of twenty-seven tons. This shows a deficiency of twenty-four per cent., which is within one per cent. of that of the cast-iron noticed in my former letter. In the absence of more extended experiments, I am of opinion that 25 per cent. may be considered as the diminution of strength, arising from the application of hot-blast.

It seems to be supposed by many, that the deficiency in the strength of the cast-iron proceeds from an excess of carbon; this has never been my opinion, and the result of this experiment has further tended to convince me that I am right. If it proceeded from excess of carbon only, the deterioration would be found to have proceeded no further than the pig-iron; this, however, I have shown not to be case. The several processes of refining, or the conversion of pig into bar-iron, entirely removes the carbon—if any remained the product would be steel, which I presume it is unnecessary for me to state is not the case—it must therefore be attributable to some other cause, and I have no doubt if the subject is taken up by parties competent to investigate it, but it will be found the reason I have assigned for it is the true one.

The bar-iron made from hot-blast pig is something lighter than that made from cold-blast, as the following will show:

Specific gravity of cold-blast bar-iron	7·6626
Ditto hot-blast ditto	7·5898

The water used was rain, at a temperature of sixty degrees.

The result of my experiments have certainly been very unpropitious to the new process. I shall, however, be most happy in receiving any information calculated to impart a more favourable view of an invention which at first promised to be attended with such beneficial results to the iron trade. The experiments I have made are within the reach of most iron manufacturers, and I sincerely hope some parties may be induced to make careful comparative trials, and to publish the result, which will be valuable, as tending to confirm or remove an impression which appears to be rapidly gaining ground, namely, that the new process most seriously deteriorates the quality of the iron manufactured under it—as far as my own experiments have gone, I am perfectly satisfied they are correct—but whether the results I have met with will be found in a general way to attend such trials, remains to be proved.

The following is a copy of Mr. Tombs' certificate, before referred to:—

"This is to certify, that I proved for Mr. Wood, of Abersychan, by my hydraulic engine, two bars of one inch one-eighth-round iron, made from hot-blast pigs, which broke under an average test of twenty and a half tons; and also two bars of one inch and one-eighth-round iron, made from cold-blast pigs, which broke under an average test of twenty-seven tons.

"*Newport, Sept.* 9. (Signed) DANIEL TOMBS."

I am, Sir, your most obedient servant,

Abersychan Iron Works, Pontypool, Sept. 12. W. WOOD.

THE RAILWAY MANIA.

TO THE EDITOR OF THE MINING JOURNAL.

SIR,—My letter of the 15th inst. concluded by some observations upon the Report of the Select Committee of the House of Lords (19th July, 1836). With your permission I will resume the subject, in continuation of my former letter, to which I beg to refer.

In the report adverted to, the noble Lords say further—

The evidence proves that this mode of conveyance (*i. e.* steam-carriages or turnpike roads), can only be applied to passengers. * * *

It appears that some experienced engineers, after a careful examination of the expenses attendant upon it, have been induced to abandon all hopes of its success, as a profitable undertaking.

It is probable, therefore, that any encouragement (such as removal of tolls, which "utterly prohibit") on the part of the Legislature would only give rise to wild speculations, ruinous to those engaging in them, and to experiments dangerous to the public!—p. iv.

I have looked carefully through and through this evidence, but could not find in it the least sanction for such conclusions, other than that given by three engineers in railway practice, whose evidence I shall here examine:—

WILLIAM CUBITT, Esq., examined.

You were one of a party of engineers who subscribed towards the building of a locomotive carriage by Messrs. Maudslay and Field?

I was, it originated in a sort of challenge, which I gave the parties to prove the possibility of doing the thing. * * A carriage was built. * * It proved that the thing was perfectly practicable, but was not economical or expedient. * * There was no other disadvantage, the thing is perfectly practicable; there is no difficulty whatever in making a good carriage, which will travel remarkably well (on the turnpike road), we have gone up steep hills with the one we had.

Who directed the form of the engine?

Mr. Field himself, subject to the approval of myself and one or two other engineers.

He then proceeds to say, he "never saw," and knows nothing practically about the contrivance of Mr. Gurney's carriages, and that it is upon an "experience" of "six or seven" journeys with one particular carriage, that he draws his conclusions—(p. 82).

Now, in the year 1836, Mr. Cubitt, a gentleman in the most extensive engineering practice, in which his name is highly and justly distinguished, first doubts the possibility, gives a "challenge," is driven from his first position—the non-possibility—and he is compelled to take up a new position—the non-economy. Were it not that his evidence refers solely to this carriage built by Mr. Field, aided by himself, and one or two other railway engineers, he might even have been driven from this second position. It is a matter of wonder that both practicability and economy were not proved utterly wanting in that carriage, seeing so many engineers had to do with it. I recollect a certain party of "experienced engineers," nay, several of the same men who directed this carriage, who, twenty or twenty-five years ago, subscribed and built a steam-boat, called the "London Engineer," intended to ply between London and Margate; it was to have been the *ne plus ultra* of London engineering, and so it proved. It was to have surpassed in excellence the many steam-boats at that time plying in Britain. And I recollect that, after great trouble and immense expense, it "proved" the non-economy of steam-boats, about as satisfactorily as the carriage experiment just cited proved that of steam-carriages. In fact, the thing was absolutely useless, except as an illustration of the homely proverb, "too many cooks spoil the broth."

But why does Mr. Cubitt give such decided evidence against the economy of this conveyance? He must have forgotten the "London Engineer," or that there was such a scarcity of funds, even to pay for this carriage, that the makers have never yet let it go out of their own custody. It is clear that there was a want of "economy" somewhere!

Mr. John Braithwaite, an engineer, in extensive employment for a projected railway, and engaged in the manufacture of a "great many locomotives for other railways," does not consider there is much difference between a railway locomotive and a common road locomotive!—(p. 85.)

Let us leave this witness, and proceed to scrutinise another railway engineer's evidence, that of Mr. George Stephenson.

When, in the first question, he is asked if he has turned his attention at all to locomotive engines on public roads, he answers immediately, "of course, I have thought a great deal about them, having been concerned in them twenty years." Ten years before a steam carriage was introduced on the common road:—

What is your opinion of them?

I think they will never be made to do any good on a common road; I do not see the slightest possibility of it.

You are well acquainted with these locomotive carriages?

I think I am, I think I have a right to say I am.

He then says he never saw one—but in possession of traditionary information, he says—

There is no doubt of making them go on a road, but not to make them pay, *for I* do not think any experienced engineer would be concerned in them.

I am fairly entitled to show the value of a witness's opinion on one point by his opinion on another point, and, with great respect, in the same witness's evidence, we have his theory of boiler explosions:—

I imagine, says he (p. 56), that there must be a decomposition of the steam, that when the iron becomes red hot, the oxygen of the steam will seize the iron, and, of course, the hydrogen is at liberty, it is separated from the oxygen, then if the plate is heated to a certain degree, it will take fire and explode.

This is absolute nonsense, Mr. Editor. A simple combustible explode without a supporter! What next?

We will here take the opportunity of placing in its true light the question as to the danger from boilers of steam carriages, since it was referred to by Mr. Stephenson in his evidence, and the noble inquirers thought proper to attach much importance, whilst they overlooked much more that really deserved their utmost attention. There may be as yet no means devised which can secure persons from accident, if a boiler having a large chamber be suffered to be introduced; but provision can be made, and in some boilers such provision is made, that if an explosion should take place, it could only be of a very small chamber, so that no serious accident could possibly result.

To recapitulate: three principal witnesses, on which the committee founded their "serious objections," are all of them attached to railways.

The first, Mr. Cubitt, driven from his original position, takes up that of non-economy, founding his opinion solely upon the before-named production of several engineers, which was six tons in weight. The second witness confessed his ignorance of the essential difference between a railway locomotive and a steam carriage; and the third witness jumbles and mis-states facts in a manner which spoils his evidence thereon, and exhibits such a limited knowledge of first principles, as to render his opinion worth nothing.*

The committee of noble Lords placed so much confidence in the opinions of these partial witnesses, that I will adduce some other evidence.

Mr. Stone, the engineer who had charge of Mr. Gurney's carriages between Gloucester and Cheltenham, said—

We have made altogether 396 regular journeys, making 3644 miles in all; our expenses in coke altogether 78*l.* One-third of this coke has been burnt in exercise and experiments when we were not running. I have taken the engine to pieces to mend the axle, and find the engine not worn or injured; and, with the exception of the brasses, there has been no perceptible wear of any part.†

I know from other evidence that this engineer offered for a contract to keep three steam carriages in repair at 3d. each per mile travelled.

My experience is given in evidence in the Lords, to the effect, that I have travelled by various steam carriages on turnpike roads upwards of 3000 miles—that I have seen most of the steam carriages and locomotive engines in the country—that I am not the partner, proprietor, or contriver of any—and I estimate the expense, including fuel, repairing, attendance, &c.—the total expense per mile at two shillings—carrying an average of fifteen passengers, at a rate from ten to fourteen miles per hour.

It is demonstrated by several impartial witnesses, that the expense of carriage by a steamer on the highway of very ordinary surface, on average road surfaces and levels, is less than 6d. per ton per mile, including payment of toll for maintenance of the road. The railway gentlemen say this price is very great, and they will reduce it. They, therefore, proceed to construct a railway; but, knowing that the surface resistance of such a road is reduced to a minimum, and that their locomotive wheels cannot have sufficient attachment for mounting slopes (for as yet they do not distinguish between the active wheels of the locomotive engine and the passive wheels of the train carriages), they proceed at immense expense to construct a railway, as near the true level as possible; so much so, that the unaided eye cannot detect the slopes. I know a valley thirteen miles from London, which is passed by horse coaches, and has been passed by steam carriages, descending on one side and ascending on the other, at a speed of eleven or twelve miles an hour. Now, although a steam carriage by the turnpike road must not only contend against a little more surface resistance, but must also work up the hill, the extra cost, after improving the common road in the best manner, for the same amount of carrying trade, crossing the valley at an equal speed, is only 400*l.* annually. Over this valley an embankment and viaduct, which cannot cost less than 100,000*l.*, is now constructing for a railway. To pass this valley, therefore, will cost annually the 5000*l.* of interest, exclusive of the more immediate cost of carriages, maintenance of way, repairs of engines, &c., which must be charged to somebody, and therefore forms, or should form, a charge on goods and passengers carried. Mr. Cubitt, Mr. Stephenson, Mr. Braithwaite, and the engineer for the viaduct and embankment alluded to, and other railway engineers, would do well to think of this. Their system may economise tractive power to the extent of 400*l.* annually, but it costs their employers more than 5000*l.* a-year to do so. Steam carriages on common roads do not require all this work, though they might perform the better for it. They can carry passengers and goods from towns situated on the lowest parts of valleys or other low countries, to towns on hill sides or on mountain districts. Not so railway locomotives; the railroad may have a very fine level, but if our residence be at the bottom of a valley, all our produce must mount a more than ordinarily steep acclivity, before we can place it on the railway.* If we reside on the high land we must have all our necessaries brought up to us at considerable expense. The whole produce of the country is on different levels, and some undulations in lines of communication are absolutely necessary. So that, even supposing such levelling as railroads demand, benefits the proprietors of them, it may be to the public a disadvantage. Now, steam carriages on the common road set the carrying trade, and all other trades and pursuits, on an equal footing.

Having thus endeavoured to point out the fallacies into which the exclusive mania for railways has betrayed the public, let me now consider the bearing of the question on another most important interest.

The turnpike roads of England and Wales alone, exclusive of highways, extend, according to a report of the House of Lords in 1829, over 19,800 miles in length; they have been constructed at great expense; the trusts are heavily in debt.† These roads form the grand currents of trade, through long-established, and well-peopled, and busy lines; on, along, and across these lines every kind of carriage and farmer's carts can pass, without a charge which can at all enrich the road trustees. On these roads competition in the carrying trade can always exercise its wholesome checks. Many of these roads, *public property, with a free carrying trade*, are at present endangered by the railway mania, which railways are *private property with a monopoly in the carrying trade*.

I am unbiassed by interests tending either way; I have felt it my duty, and for my character as an engineer, to refuse all railway business; and I feel it a duty to utter these opinions, the rather that they do not at the moment coincide with the popular feeling on the subject; for the public act in such cases from "feeling" alone, never from cool and deliberately formed opinions. The power of steam locomotion by the turnpike road has certainly been attained. It is true the capital, enterprise, and exertion of one or two individuals may not be able to cause its general adoption in the face of the present formidable opposition; out an approving act of the legislature might do much to help it; and such, considering what Parliament has already done to delay the system, it is unquestionably entitled to. The commissioners who have been interested with the selection of railway lines in Ireland, in consequence of the erroneous supposition, that the benefits of steam carriage can only be had by railway, ought to investigate the facts to which I have referred. But let me ask, is not the entire subject such as would warrant a commission for its express and separate investigation? Certain it is, that instead of encouraging by legislative enactment, the improvident speculations referred to; "the carrying trade should be suffered to remain perfectly free." Such a system alone would enable private capital to compete with public companies; and what reason the legislature can urge for giving to a company greater immunities and privileges than individuals possess, I am at a loss to divine. Every artificial stimulus of this kind is immediately disadvantageous to other parties with claims nowise inferior. These bodies do not stand on equal ground; they do not, for by the nature of the case they cannot, come into fair competition with road-trusts and individuals; and against the competiton of steam carriages on common roads they are protected by the prohibitory tolls to which we have alluded. Until these are repealed, not another railway bill ought to pass the legislature; for it is at least possible that the repeal may render all of them losing concerns.

To the introduction of steam power and the extended adoption of machinery, our commercial prosperity is attributable; and a further extension is as necessary for maintaining our proud position as for advancing it. In the further adaptation of steam power to agricultural purposes, which recent facts encourage, we foresee a demand for, or the probability of a more educated agricultural community. The surface of our country is not only well-cultivated, but the depths are rich in mineral treasure; and it is the natural seat for metalliferous manufactures. We have a population, numerous, industrious, becoming gradually more moral, and with added capacities, and facilities of mental culture for every science, and for the improvement of every ingenious and useful art.

All these circumstances and considerations render it the more desirable, that just views should prevail on the great topic discussed in this letter; and they render it above all indispensable, no less as a matter of national policy than of equal individual justice, that undue privileges and immunities should not be accorded to one party, merely because they have wealth and the momentary popular prejudice on their side; while undue obstacles are placed in the path of another party, for no conceivable reason but that the success of their plans would reduce that of their rivals to its just and proper level in the public mind. With many thanks for the space you have allotted for this letter,

I am, Sir, your obedient servant,

22, *Fludyer-st., Westminster, Sept.* 22. ALEXANDER GORDON.

ESTIMATE OF SOLAR HEAT ANNUALLY RECEIVED BY THE EARTH.—The surface of the globe being four times the area of a section of the sunbeam constantly incident on it, and the quantity of heat continually received by the earth, (or, at least, into its atmosphere,) being necessarily greater than the maximum *ever* observable at its surface, it follows from this that the solar heat annually incident on our globe would suffice to melt, *at least*, 84·54 feet of ice over its whole surface. Perhaps 100 ft. would be nearer the truth; the radiation here assumed as an example, being by no means the greatest I have observed at the Cape. The clouds, however, probably radiate off a large proportion of this heat as soon as received, and prevent its ever reaching the ground.—*Sir J. Herschel.*

INDIAN COAL.—New mines of coal have recently been discovered at Hanarecbang and at Bidgegur, in the south-eastern corner of the Mirzapore district, said to be superior to the coal of Burdwan, This discovery will probably form an important era in the history of steam navigation in India.

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* Some stress has been laid on the alleged circumstances of horses shying at steam carriages on common turnpike roads; but really the objection seems worse than unmeaning to those (and hundreds such must be among your readers), who have witnessed, for months together, during the summer and autumn of 1836, steam carriages of no very refined construction, running hourly on the most populous thoroughfare of the suburbs (through the heart of the City to the New Road, &c.), without probably having, in any one instance, seen them noticed by any horses, except such (and there are many) as shy at *every* species of carriage they pass. It is true, a coachman out of place, named Palmer, was called, who said he had received two guineas for a day and a half's attendance. This person stated he had met a steam carriage on the wrong side of the way, "nearly in front of his horses," when driving a noble lady's carriage—and that the pole was broken against a post; but this did not produce the least effect on the disposition of the horse, "any further than, as you go down the road, if you meet a buss (omnibus) making a noise, he always seems to shy—he is always fearful when he *meets a buss*."

† I have given these facts at full length in my "Treatise on Locomotion and Interior Communication." Third edition.—*See* p. 85.

* Or rather before we can unload and reload it on a railway waggon.

† The debts upon which amount to nearly 9,000,000*l.* and several trusts are insolvent.—*Report*, Aug. 9, 1836.

MICA,—VULGARLY CALLED TALC.

This beautiful substance, which may be termed elastic glass, is capable of being appropriated to many useful purposes, to which it has not been hitherto applied, except by one or two individuals. One reason for the apparent neglect of this most beautiful and unique mineral may have been its scarcity in this country. We have frequently purchased it at the rate of twenty and twenty-five shillings a pound, whereas it may be imported at one-third of the sum. We believe that a considerable proportion of the mica imported into England is required for a new kind of stove, which we, however, have never seen in operation. It is used also in the construction of the cards of magnetic compasses, as it has the peculiar property of always preserving its plane, so that when pasted to the under surface of the card it prevents it from warping.

Several years ago we applied mica to a new and very useful purpose, for which it is particularly adapted, and we should have publicly recommended its adoption had not gas lights almost entirely superseded the Argand Lamp. As glasses, however, are often used with gas burners, we take the opportunity of stating, that in order to convert the mica to this purpose it should be split as thin as possible, and then bent round into a cylinder, the edges lapping over each other a little, and secured by a thin slip of brass rivetted to the mica. It is infinitely preferable to glass for this purpose, as it is neither liable to break nor to be burnt.

There is another most important use for which mica is peculiarly adapted, although we have never heard of its having been so applied. We advert to its substitution for glass in hot-houses, as the substance, from its elasticity, would endure the most tremendous hail storms, which are often known to destroy hundreds and thousands of glass panes. Mica has long been used as a substitute for horn in lanterns, and the application is judicious, as independent of its superior transparency, it is not liable to be destroyed or even affected by contact with the flame, which would blister and destroy horn. We are not aware that mica has ever been used for the slides of the magic lantern, but it is preferable to glass, because independent of its elasticity, it admits of having the figure drawn and coloured with more facility than glass.

We have also succeeded in silvering mica, so as to form very perfect and elastic mirrors, which may be carried in a pocket-book.

Having occasion for a cylindrical mirror for that beautiful optical instrument for restoring distorted images to a regular figure, we found mica particularly adapted for our purpose, from the facility with which, after being silvered, it could be bent into a cylindrical form. We believe that no name has been assigned to this elegant instrument, which has, however, been fully described in "Hooper's National Recreations," and in Priestley's large "Treatise on Vision, Light, and Colours," amongst the plates to which it is numbered 53.

We have tried some experiments with the mica, as a surface upon which to work with the graver or the etching tool, and we have long thought that it might be advantageously used in the lithographic process. If our conjecture should be well founded, it would be extremely acceptable to travelling artists, as they might make their sketches on the spot upon the leaves of mica, and afterwards pass them through the press. We have now before us a small copy of a well-known picture by Wilkie, printed in lithography, from a surface of mica, and we shall leave it at our office for the inspection of any scientific gentleman who may wish to examine it.

A few days ago we met with some very fine specimens of water colours upon mica, executed at Patna, in Hindostan; and as this use of the substance is probably new to the scientific gentlemen now in Liverpool, we have prevailed upon the gentleman who has the specimens, to leave some of them with Messrs. Wordley and Mayer, silversmiths, in Lord-street, for the inspection of the curious. One of these specimens, representing Indian costumes, may also be seen in the window of our office. If the surface is suitable for oil painting, it would open quite a new field to our artists, especially our miniature painters, as the picture would at one process be painted and glazed.—*Liverpool Paper.*

NEW SAND FOR GLASS.

The silver medal of the Society of Arts was awarded for the discovery of a sand in the colony of New South Wales, eminently fitted for the manufacture of the finer kinds of glass.—The following notes on the subject are interesting:—In the year 1831 it was observed, that in many places between Sydney and Botany Bay the surface of the ground was covered by a remarkably pure and white silicious sand, derived from the decomposition of one of the beds of sand belonging to the coal formation. Mr. King, of Sydney, the discoverer, being of opinion that this sand would be found peculiarly applicable to the business of glass-makers, forwarded eleven bags of the same to his agents, Messrs. Buckle, Baxter, and Buckle, of London. These arrived in June, 1832, and some was put into the hands of Messrs. Pellatt and Co., of the Falcon Glass-house, for trial. In August of the same year they reported the result of these experiments. From their report the following is an extract:—"We find the sand from Sydney to be decidedly superior to any we have previously employed. The most esteemed property of this sand, and that which makes it of the greatest importance to glass-makers, is derived from the absence of oxide of iron and every other combination that would affect the colour of the glass when made. It is also free from insoluble matter. Glass made from this sand is more brilliant and watery than any other. We consider it fortunate at this period that this sand has been discovered, as the sand with which most glass-makers were supplied is now of very bad quality, and has been given up by many." According to an analysis of a sample of this sand, made conjointly with Mr. Children, of the British Museum, and Mr. Garden, it appears to consist of 95·0 silica, 2.2 sulphate of lime, 0.4 oxide of iron, with a trace of alumina—making 97.6; leaving 2.4 for organic matter, water, and loss, the whole will be 100.0. On application to Mr. Pellatt the following further particulars were obtained:—He says that the recent arrival of a few hundred weight of this superior silex had enabled him to make a second experiment, which turned out fully as well as the first. He is of opinion that the Sydney sand exceeds all others heretofore in use, for whiteness, brilliancy, and fusibility; and he has little doubt, should the freight be moderate, that this comparatively pure material will be imported in large quantities for glass-makers' use in this country. He had mixed it with the usual proportions of carbonate of potash and nitrate of potash, with a rather less proportion of manganese than other sands require. Mr. Pellatt adds, that he hopes soon to be able to report on the Sydney sand as regards flint glass ware for optic plate. A few tons of the same kind of sand were lately imported into Liverpool, and were eagerly purchased, so that a considerable improvement in the qualities of the finer kinds of flint glass may soon be expected.

Singular Fact.—The first person who constructed a machine in which steam was successfully applied to useful purposes was *Captain* Savery, who obtained his title from the Cornish miners, according to their practice of giving it to the head engineer. A singular fact may be mentioned in reference to him; having drank a flask of Florence at a tavern, and flung it, when emptied, on the fire, he called for a basin of water to wash his hands; a small quantity which remained in the flask began to boil, and steam issued from its mouth; it occurred to him to try what effect would be produced by inverting the flask and plunging its mouth into the cold water; putting on a thick glove to defend his hand from the heat, he seized the flask, and the moment he plunged its mouth in the water the liquid rushed into the flask and filled it. It was this circumstance that suggested to Savery the possibility of giving effect to the atmospheric pressure by creating a vacuum in this manner; he thought that if instead of exhausting the barrel of a pump by the usual laborious method of a piston and a sucker, it was exhausted by first filling it with steam, and then condensing the same steam, the atmospheric pressure would force the water from the well into the pump barrel, and into any vessel connected with it, provided that vessel were not more than about thirty-four feet above the elevation of the water in the well. He perceived also, that having lifted the water to this height, he might use the elastic force of steam to raise the same water to a greater elevation, and that the same steam which accomplished this mechanical effect would serve, by its subsequent condensation, to repeat the vacuum and to draw up more water. It was on this principle that Savery constructed his first engine: it was materially improved by Newcomen in 1705: Boighton afterwards simplified its movements without changing its principle, and from his time no considerable improvement was made till that of Watt.—*Williams's Seven Ages of England.*

MISCELLANEA.

Rotatory Steam-Engine.—Mr. Ruthven has now got the rotatory engine upon Avery's principle erected, and we saw it in motion on Wednesday. Having described it before, we shall merely observe at present, that it moves by the reaction of high pressure steam, which rushes through two small orifices at the opposite sides of two hollow arms, and impels them in a circular direction with incredible velocity. The engine has neither piston, cylinder, beam, crank, nor valve. The arms are of two feet six inches radius, and as they perform about 3000 revolutions in a minute, their extremities must move at the rate of a mile in eight seconds. This very high velocity, or something approaching to it, is essential to the working of the engine. No noise is heard when it is in motion, but only a low humming sound like that of a boiling kettle. The trial on Wednesday was merely to show its mode of operating; but it is soon to be employed in some heavy work which will test its powers, and we shall then speak of it more at large. If its capabilities correspond to the inventor's description, it will deserve to be considered one of the happiest applications of steam power which has ever been given to the world.—*Scotsman.*

Extraordinary Phenomenon.—A letter from Mihalysa, in the county of Yalads, in Hungary, says, that on the 19th of July, at half-past ten o'clock at night, there appeared in the horizon above the mountains situated between Esab-Rendeck and Sumigh, not far from the forest of Bakony, an immense column of flame, which rose with a dreadful noise and roaring, like that of distant steam, followed by two violent explosions, with a short interval between them. This phenomenon terrified, not only the inhabitants, but the domestic animals. The explosions were so violent that the ground trembled, and at Sumigh and Milhalysa the windows were so shaken, that they were expected to be broken to pieces. The phenomenon was of only a few seconds' duration, and after the explosion all was buried in obscurity. An explosion nearly similar was heard on the 5th of January in Syria.—*Journal de Frankfort.*

Progress of Science.—We understand that the highly scientific mode of making instantaneous telegraphic communications by galvanic power, which has so long been considered attainable, has already been put to the most decided test on the London and Birmingham Railway, under the direction of Professor Winston and Mr. Stephenson, the engineer to the company. Four copper wires, acted upon at each end of the line at pleasure, by the agency of very simple galvanic communicators, have been laid down on the line of the London and Birmingham Railroad to the extent of twenty-five miles. They are enclosed in a strong covering of hemp, and each terminus is attached to a diagram on which the twenty-four letters of the alphabet are engraved, in relative positions, with which the wires communicate, by the aid of moveable keys, and indicate the terms of the communication. The gentlemen to whom we have referred, we believe, are fully satisfied that communications to almost any extent may thus be made instantaneously by the agency of galvanism; but we understand that Professor Winston only takes credit to him for the adaptation of the principle. How far this mode of communication will be useful to the commercial or any other portion of the community it will be difficult to determine: unless its benefits be extended to the information of all classes, it will, doubtless, pave the way to many abuses.

Toad Imbedded in Stone.—We have frequently heard of toads being found alive imbedded in solid stone, where they might have domiciled in a dormant state (for aught we know) from the time of the flood. The fact we are about to record is scarcely less remarkable. About a fortnight ago, while a workman was employed in digging the foundation of the wall on the property of Mr. Swainson, of Cooper-hill, close to the river under Walton church, he found a large toad in a solid bed of marl six feet below the surface of the soil. It was domiciled in a hole the size of itself, and was of so large a size that those who saw it considered that it was about a pound in weight. The workman accidentally cut it in two with his spade; but, though thus fatally disturbed from its long repose, it exhibited for some time evident symptoms of vitality.—*Preston Chronicle.*

Improvement in the Jacquard Loom.—A great improvement has just been effected in the Jacquard loom, by which all the weights are dispensed with, and steam-power is used to work the machinery. By this new machine silks of any pattern, of superior texture to the French, and of the most even fabric, can be made by children or women. Springs are used to regulate the yard-beam without reference to its diameter, and by a simple and ingenious contrivance, the yarn and cloth beams can be instantly stopped should the weft break.—*Blackburn Standard.*

Artesian Wells.—An economical and easy method of sinking Artesian wells, and boring for coal, &c., has recently been practised near Saarbruck, by Mr. Sellow. Instead of the tardy and costly process of boring with a number of iron rods screwed to each other, one heavy bar of cast-iron, about six feet long and four inches in diameter, armed at the lower end with a cutting chissel, and surrounded by a hollow chamber, to receive through valves, and bring up the detritus of the perforated stratum, is suspended from the end of a strong rope, which passes over a wheel or pulley fixed above the spot in which the hole is made. As this rope is raised up and down over the wheel, its tortion gives to the bar of iron a circular motion, sufficient to vary the place of the cutting chisel at each descent. When the chamber is full, the whole apparatus is raised quickly to the surface to be unloaded, and is again let down by the action of the same wheel. This process has been long practised in China, from whence the report of its use has been brought to Europe. The Chinese are said to have bored in this manner to the depth of 1000 feet. Mr. Sellow has, with this instrument, lately made perforations eighteen inches in diameter, and several hundred feet deep, for the purpose of ventilating coal mines at Saarbruck. The general substitution of this method for the costly process of boring with rods of iron may be of much public importance, especially where water can only be obtained from great depths.

Geology.—The following are notes of a paper by Mr. Babbage, on impressions in sandstone resembling those of horses hoofs:—"During a recent visit to Dowlais, it was mentioned to the author, that in the channel of a stream on the extensive moor called Pwll y Duon, and about seven miles from Merthyr Tydvil, there are many impressions considered by the country people to have been made by horses hoofs. The stratum of sandstone in which they occur is called the Farewell Rock, being the lowest bed of the coal measures. At first sight they presented a strong resemblance to the marks which the hoof of a horse would leave on a soft surface; but on a closer examination, Mr. Babbage found that the part which should have received an indention from the frog, was in relief, and resembled rather a cast of the frog itself. The first mark examined by him proved to be the letter G, which had been carved on the rock by some whose initials were G. H. This discovery made him inspect the others more minutely, and he ascertained satisfactorily that they were not artificial. Similar impressions were noticed by him at several places on the moor. The author then refers to analogous casts in the old red sandstone of Forfarshire, and there called Kelpie's feet. In attempting to account for the marks, Mr. Babbage described some observations recently made by Mr. Lyell, on impressions left by Medusæ on the rippled sand near Dundee. On removing the gelatinous body of the animal a circular space was exposed, not rippled, but having around half the border a depression of a horse-shoe form. These marks, however, were not considered by Mr. Lyell as identical with those called Kelpie's feet, but merely so far analogous as to invite further observations, and to make it desirable to possess drawings of the impressions which different species of Medusæ leave when thrown by the tide upon a beach of soft mud or sand."

Magneto-Electric Currents.—M. Auguste de la Rive has been studying the properties of magneto-electric currents, and among other results he finds, that the helix of a metallic thermometer heats to seventy degrees, when there are but two currents alternately contrary every second; to fifty-five degrees with nine currents; to one hundred degrees with twenty currents; and that a fine wire of platina has been heated red-hot when the succession of currents has been even more rapid. Chemical effects are subject to the same influence, only that there is a limit at which the heat of decomposition slackens. The influence of this speed is also felt in physiological processes, which acquire much greater energy than when produced by voltaic currents; a phenomenon which may be attributed to the interruption and alternately contrary direction of magneto-electric currents, and which, perhaps, may become advantageous in the practice of the medical art.

Springing a Mine.—A "vast concourse" of persons attended, lately, on the line of the St. Lawrence Canal, to witness the explosion of a mine, which contained between five and six hundred pounds of powder. The experiment was successful—no accident occurred.

Swiss Association for the Promotion of Public Welfare.—This association held their meeting this year at Geneva. The society proposes to itself more particularly the investigation of three points of equal importance: popular education, national industry, and the best plan of relief for the poor. On the subject of education, the society came to a unanimous resolution that no education was of any value if it did not propose moral cultivation and improvement as the primary object of its endeavours. Zellweger, from St. Gallen, had sent in a treatise to condemn any interference on the part of government in matters connected with the corn laws; but, at the same time, he admitted that the peculiar position of Switzerland made it desirable to form magazines of flour as a provision against times of scarcity. This treatise led to a lively discussion. A paper by Professor de Candolle, on the history and future prospects of savings banks in Switzerland, excited much interest. It was agreed that the next meeting should be held in Berne.

Comparative Anatomy.—A beautiful instance of the perfection of the knowledge of comparative anatomy, as applied to Ichthyology, was given by Sir P. Egerton to the Geological Section at Liverpool, on Friday the 14th. A scale found by him in one of the Yorkshire formations was sent to M. Agassiz, with a request that he would give his opinion as to the order in which the animal should be placed, and any detailed account of the probable shape and size of the fish he might think proper. This was done, and the whole organization of the fish regularly given. Sir Philip subsequently found a perfect specimen of the animal, which tallied exactly, *i. e.* as far as a fossil would allow, with M. Agassiz's description. The announcement of this fact was received with great applause.

Wastes in Collieries.—On Thursday morning, says the *Preston Chronicle*, two men, named Bolton and Haliwell, were employed in removing the pillars in the Bugh colliery, when the roof fell in and buried Bolton under a weight of at least twenty-five tons; he was quite dead when dug out. The coal wastes or exhausted mines were formerly left in this condition—the roof was supported at necessary distances by masses of coal, like rugged pillars, left in removing the general body. The spirit of economy induced the owners to dispense with the columns, allowing the roof to fall, and close up the workings—a miserable spirit, to which may be traced the masses of small unused coal left in the strata to generate "fire-damp and choke-damp," often carried from these wastes into the mines under operation. Depression of the surface, often cracking and destroying houses and other buildings, may also be traced to the removal of the supporting pillars, especially when the *seam* of coal lies "near the day." The Editor of the *Merthyr Guardian* observes, "They manage these matters better in the coal levels of South Wales. The quantity of pit-wood used as props is enormous, and far beyond the point of necessity for safety."

Important Invention.—Dr. Christopher, C. Rice, Dr. Anthony Hermage, Professor of Chemistry and Natural Philosophy, at Mount St. Mary's College, Emmetsburgh, and Professor J. Gillmeyer, of Baltimore, are associated as proprietors of a newly invented paddle-wheel for steam-boats. As the paddle of the wheel now in use, when at work, strikes the water at an angle of thirty-six or seven degrees, the water, of course, offering its resisting force to the nearly horizontal paddle, a great degree of steam power must necessarily be applied to the main crank, so as to overcome the resistance of the opposing element. Thus, from the shock made by the two conflicting powers, the boat sustains a shock or jar, and causes the plunge of the steamer at each stroke of the paddle, which is not only as unpleasant to the passenger as it is injurious to the vessel, but it retards the progress of the steamer also. The new patent paddle strikes the water perpendicularly, thus doing away with the cause of the convulsive plunge of the boat. It works at almost any depth under water, thus proving itself fit for the ocean equally as for the river boat. It rises also perpendicularly, and thus causes no "back water," and on this account shows itself applicable to canals, as it is to oceans or rivers. All this is effected by the manner in which the paddles work, viz., on cranks and pivots, and an eccentric revolution of its wheel. All the extra power requisite to be applied to the present paddle in use for breaking at first and lifting afterwards the water is saved in this instance, and which, at a moderate calculation, must be equal to one-third of fuel, and propel the boat one-third faster. Some of the most scientific men in the country, who have seen this beautiful piece of machinery, have highly praised it. We recommend it to the serious consideration of those who at this time are engaged in steam-boat navigation.—*American paper.*

New Railway Power.—A proposition has been made, which has received a favourable consideration, for working an intended railway 300 miles in length in the State of Virginia, America: there are a series of waterfal's in the immediate vicinity of the whole length of the line, from which it is proposed to cut numerous canals to obtain a head of water for working water-wheels, to be applied in a similar manner as fixed engines for moving the railway carriages.—*Civil Engineer.*

Lancashire Coal-Field.—From a paper read by Mr. James Heywood at the late meeting of the British Association, it appears that the coal-fields of Lancashire cover a space of nearly 400 square miles, more than half of which is contained in the southern division of the county. Some idea of the quantity of coal consumed in this country alone may be formed from the fact stated by Mr. Heywood, that in 1836 the quantity of coal received in Manchester amounted to 913,991 tons, the value of which would be nearly 500,000*l.* We have often heard fears entertained that at no distant period the price of coal would be much raised on account of the increased demand, and the greater difficulty in mining, from the better parts of the field becoming exhausted. We believe there are no just grounds for much fear on that account. According to the best geologists the coal-fields already discovered will furnish this most valuable element of our greatness for 1800 years yet, even although twice the quantity of what we consume at present were needed. As for the best parts of the various fields being soon exhausted, even granting it to be true, we may set against that the improved facilities for transporting coal by railroads, which must tend both to increase the supply of coal and to equalise prices.—*Bolton Free Press.*

Saddle Iron.—Pig iron has its name from a fancied resemblance to a sow and pigs, which is given to the metal on running it into the sand. There is no doubt but the form was selected for its convenience. A Turkish iron master in Romelia, from the same motive, has adopted one which his brethern in this country of facilities would be long in seeing the propriety of, namely, that of a saddle. At one and a half league to the east of Egri-Palanka, in Romelia, we visited some very picturesque *cavages*, established for procuring the octahedral iron ore, which is disseminated in almost imperceptible crystals in a decomposed state. A stream of water is made to fall upon the rocks, to enable the workmen to separate the iron; and the smelting of it is not less curious; the kiln is opened every sixteen hours, and an immense quantity of charcoal is consumed. *The iron is cast in the form of a saddle, that it may be more easily transported on asses.* These mines afforded a great quantity of iron, which would be of good quality if it were properly treated."—*Boué's Geology of Turkey.*

Probate Duty on Foreign Bonds.—A case of some importance to the holders of foreign bonds, we understand, is about to be tried in the Court of Exchequer, the result of which will determine whatever Spanish and other foreign bonds, negotiable in England from hand to hand (though the foundation of the security itself is claimed to be out of the jurisdiction of the Prerogative Court), are liable to probate and administration duty. It has been already decided by the same court, that foreign funded property possessed by an Englishman dying in England, is not liable to probate or administration duty.

Water for the Metropolis.—There are in London eight public water companies, namely, the New River, which supplies 73,212 houses with an average daily quantity of 241 gallons, at an anpual charge of 1*l.* 6*s.* 6*d.* per house; the East London, 46,421 houses, with 120 gallons, at 1*l.* 2*s.* 9*d.*; the Lambeth, 16,682 houses, with 124 gallons, at 17*s.*; the West Middlesex, 16,000 houses, with 185 gallons, at 2*l.* 16*s.* 10*d.*; the Chelsea, 13,891 houses, with 168 gallons, at 1*l.* 13*s.* 3*d.*; the South London, 12,046 houses, with 100 gallons, at 15*s.*; the Grand Junction 11,140 houses, with 350 gallons, at 2*l.* 8*s.* 6*d.*; and the Southwark, 7100 houses, with 156 gallons, at 1*l.* 1*s.* 3*d.* per annum.

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The Mining Journal
AND COMMERCIAL GAZETTE.

SUPPLEMENT---XXV.

SEVENTH MEETING OF THE BRITISH ASSOCIATION.

[*Concluded from page 94.*]

Our present Supplement will bring to a close the report of the late meeting of the British Association at Liverpool; and from the ample mass of valuable matter, both practical and scientific, which was laid before the Association on that occasion, we shall now have selected all which is likely to prove interesting to the readers of this Journal, thus allowing our future Supplements to be devoted to their professed object—or Reviews, Foreign Extracts, and similar matter, in which we have unavoidably fallen much in arrear during the progress of this report.

In the proceedings of the Geological Section, to which our attention will now be devoted, there is much that is highly interesting to the miner, as connecting theoretical researches with those practical facts which are brought daily before his notice—a course from which we apprehend the most valuable ultimate results, notwithstanding the difficulties which have hitherto embarrassed the science, occasioning many conflicting opinions among those who have given it attention.

The contradictory views which are now entertained by distinguished men, may, probably, with some of our mining friends, throw a degree of discredit upon inquiries of this nature—and they may even be induced in consequence to consider them hopeless and unavailing. Against any such hasty conclusion, we would, however, protest, calling to mind both the natural difficulties of the science of Geology, and the very short period that it has obtained that degree of attention which its importance deserves. If we look at the progress of other sciences, we shall find that long periods have elapsed before correct principles were thoroughly ascertained and demonstrated, and those doubts and difficulties which embarrassed them at the onset were entirely cleared away and removed. This preliminary labour has, indeed, in most cases, occupied a far longer space of time than has elapsed since the first introduction of Geology as a science; and when we view the rapid strides it has lately made, and the degree of precision which already distinguishes many of its departments, we feel sanguine as to the ultimate results which may be expected, and would anxiously impress a similar conviction on our readers.

It must be a subject of regret to those who entertain views like ourselves, that the phenomena of primary geology and metalliferous deposits (although possessing such paramount claims to attention), should at the present time be, in some measure, overlooked by the cultivators of this science—a subject on which we had occasion to remark in our review of the late volume of the "Geological Society's Transactions." One reason of this is, no doubt, obvious enough—the dark, rugged, and suffocating depths of our mines, do not offer the most convenient or accessible field for observation; and without undergoing a considerable degree, both of fatigue and inconvenience, there is little to be learned respecting the phenomena which they present to our view.

We have pleasure, however, in adverting to the labours of the geologists of Cornwall, who, notwithstanding the difficulties and inconveniences alluded to, have most perseveringly explored the mines of that county, and brought to light various highly interesting facts with regard to subterranean phenomena. Of the truth of this remark, abundant evidence will be found in the proceedings of the British Association at their late meeting—the principal information afforded on mineral veins, and other subjects connected with mining, having been brought forward by gentlemen resident in Cornwall, or connected with that county. Much praise is also due to those members who brought forward the valuable information relative to our coal districts, to which we shall shortly have to advert.

That these labours are highly honourable to the parties engaged, and also most promising as regards their results, must be sufficiently apparent to all, while they will, we hope, have the effect of stimulating similar researches in other mineral districts, as yet imperfectly explored, and presenting a wide and ample field for future observers. To this field we would more especially direct the attention of the practical miner, who, when possessed of the requisite elementary knowledge, enjoys such numerous facilities for observing a most interesting class of natural phenomena, and rendering them useful and subservient to his professional avocations.

At the meeting of the Section of Geology and Geography, on Monday, the principal communications brought forward had reference to the alluvial accumulations now in progress in the estuary of the Mersey, and to the identification of some portions of the new red sandstone series in this country with their equivalents on the continent.

The first paper read was by Mr. Whewell, "On the Changes of Level of Land and Water," which have taken place, or may be likely to do so. He mentioned that this was one of the questions proposed by the Association, and for which a grant of money had been voted—namely, to ascertain with great accuracy the differences of level of a number of points in two straight lines, at right angles to each other, and terminating on the sea-coast. He referred to some of the many indications of change of level, which may be observed in different parts of the world, especially the occurrence of elevated beaches; and alluded to the ease of determining changes of level in seas having little tide, as in the Baltic, compared with some of the parts of the coasts of Great Britain, where the tide rises very considerably. He then mentioned, that although a portion only of the task prescribed had been performed, he could vouch for the accuracy of the survey, which had been made in a line from Bridgewater to Axmouth. The gentleman who effected this survey was Mr. Bunt, of Bristol, and the line is the same as that chosen formerly for a ship canal, between Bristol and the south coast of Devon.

Mr. Smith, of Jordan-hill, called the attention of the Section to a paper he had lately communicated to the Geological Society, respecting changes of level of land and sea in the west of Scotland, and stated that he should be glad to communicate, if required, the information he possessed on this subject, at any of the sittings of the Section. Mr. Sedgwick remarked on the future utility of observations made with accuracy at the present time. The line determined by Mr. Bunt would serve as a kind of base to work from, and the continuation of the survey would bring to light many facts, that might be used with advantage by subsequent observers.

The next communication brought forward, originated also from a question proposed by the Association at a former meeting, and submitted to a committee. This committee undertook to make experiments, for the purpose of determining the quantity of silt in sea-water at different depths; but of their number, the only gentleman who had performed an extensive series of experiments was Captain Denham, of Liverpool, who now made a report to the Section, of which the following is a brief outline:—

He stated that the proportion of insoluble matter contained in the Mersey, amounts to twenty-nine cubic inches in the flood, and thirty-three inches in the ebb, in each cubic yard of water; evincing a preponderance of one in eight in the matter of the ebb, or 48.065 cubic yards of silt, &c., which is detained by the banks outside the Rock Narrows each tide, with the exception of what the succeeding ebb disturbs, at the exhausted stage of the former ebb. Thus, the ebb of to-day ranges over sixty four square miles, and the next ebb over forty-four square miles, reducing by one-third the first day's layer, that being the relative proportion of silt held in solution, and deposited over the outer area, at the northern margin of which the cross-set of the Irish Channel ebbs, limits the deposit by sweeping into broad water what may extend so far. Now, the excess of silt on the 730 refluxes of tide that occur in a year, amounts to 35,087,450 cubic yards, capable of spreading a layer, if equally disseminated, of twenty-one inches thick over the first tide area; one-third, however, is disturbed, and carried over the second tide area; or there is an uniform increase of the banks, and decrease of water in the channels of the estuary of the Mersey, amounting to seven inches per annum. This deposition of matter is, however, very unequal, some parts of the coast and of banks receiving great accumulation, while others are often taken away. At the quarantine ground, the bed of the river shoaled up twenty-two feet in eight years, and then eleven feet in two years, over a space of half a mile long by one quarter of a mile wide, and yet this was swept away in eighteen months. Captain Denham had been examining the port of Liverpool for fourteen years, and he infers from his observations, that a time will arrive when no access to this port could exist, unless man sets bounds, by his ingenuity, to the operation of tidal action. He made a number of local observations, which showed the diligence he had exercised in both planning and executing whatever he conceived might benefit this most important port; and he finished by an explanation of his principle of a constant sea level, which he had ascertained to be at three hours before, or three hours after high water, and by exhibiting the instrument which he had employed in drawing up water from different depths.

Mr. De la Beche pointed out the great importance of these experiments, both to the scientific and the practical man, in affording information concerning operations and works on the banks of estuaries and rivers. He conceived that the utmost caution should be used in making embankments, as in most instances they had proved detrimental to the navigation.—Mr. Yates spoke also of the enormous quantity of silt determined by Captain Denham, as being of vast importance in illustrating the opinions of Mr. Lyell, on the changes produced on the earth's surface, by causes still in operation. He alluded to a communication made some time ago by Mr. Horner, on a similar point, namely, the quality of earthy matter contained in the waters of the Rhine.—Lord Northampton gave Captain Denham's experiments as an example of the importance of the British Association, and of its peripatetic character. The important port of Liverpool has been ever in great danger of having its navigation seriously injured by the accumulation of silt at the mouth of the Mersey. In consequence of a question proposed by the Association, the true nature of the case had been discovered, and remedies pointed out.

The President called on the Rev. Mr. Yates, who exhibited to the Section some interesting remains of fossil vegetables found in the new red sandstone of Worcestershire. He mentioned the discovery of similar remains in the same formation in other parts of England—as at Coventry, where trunks of trees, of a considerable size, had been found; and stated, that in the Royal Institution of Liverpool is preserved a fossil trunk, found in excavating Prince's Dock. The specimens laid before the Section were from two quarries between Worcester and Ludlow—one in the parish of Stanford, and the other in Ombersley; the former being where the new red sandstone joins the Silurian rocks. In this quarry the stone is rather greenish, like coal sandstone, and not unlike the Keuper of the Germans; but it may be traced, in a line of about ten miles, into sandstone of the usual red colour. In the second quarry, branches of trees have been discovered, and trunks partly converted into coal: each trunk seems imbedded in a cylindrical mass of ferruginous matter. Through this quarry a trap-dyke passes, altering the rocks on each side. A specimen of the metamorphic rock, encrusted by chabasie, was exhibited. The general appearance of the quarry led Mr. Yates to the conclusion that there had been a deposit formed by a current near the shore of a sea, which deposit had been fixed in a bay or recess, where the remains of vegetables lay without being disturbed; and he alluded to the banks at Liverpool, where scarce any drifted plants had been discovered, owing to the continued motion of the currents, while they might be found in coves along the shores where the water was less agitated.

Mr. Murchison was then requested to answer a question respecting the identification of this sandstone with some of the divisions proposed by continental geologists. Mr. Murchison stated, that, in connexion with Mr. Strickland, he had pointed out the identity of the variegated marl, or upper stratum of the new red sandstone, in the counties of Warwick, Worcester, and Gloucester. In this stratum they had observed a thick band of sandstone inclosing a peculiar bivalve shell, not yet determined—the sandstone also contains remains of fish, and perhaps of Saurians. They were able to determine the superposition of these beds over the sandstone described by Mr. Yates, and also a total difference in the imbedded fossils. Mr. Murchison considered that he was warranted in referring Mr. Yates's sandstone to the *Grès bigarré* of the French, and the upper beds to the Keuper of the Germans. In this opinion he was the more confident, as M. Adolphe Brongniart had identified a perfectly distinct series of vegetable remains in these two divisions of the sandstone formation. The opinion of Dr. Buckland respecting the age of some of the Warwickshire beds, must be considered premature, as his data were very insufficient: indeed, the Saurian remains, which had been so important an argument in favour of the supposition, were no longer to be found. Mr. Murchison referred to Dr. Lindley, who described to the Section the characters of the fossil plants discovered in the English formation of *Grès bigarré*. A discussion then took place respecting the ages of the new red sandstone divisions. The Rev. Mr. Clarke exhibited specimens of vegetable remains inclosed in new red sandstone from America, transmitted to him by Professor Hitchcock, who discovered the marks of the steps of birds in this rock a short time since. In a letter to Mr. Clarke, the Professor has notified further discoveries of these singular steps, and also the remains of Saurians, in this formation. In greywacke he had also discovered the remains of Marsupial quadrupeds. Mr. Sedgwick conceived the classification of the different parts of the new red sandstone series as one of the most important points to be determined in the science. He pointed out a lower member of the series that immediately overlay the coal, although but rarely conformable to it: he has found in it coal fossils as Stigmaria and Lepidodendron; he had observed it lately at Kendal; he considered it highly important to determine this member of the series, as well as the *Grès bigarré*, which lay above it. There was a difficulty in doing so in this country, from the absence of the Maschelkalk; but the fixing the proper place of the members of this new red sandstone series in general was of the utmost importance, as being the base on which all geological classification was founded. The prevalence of much of the red oxide of iron in rocks was also unfavourable to the preservation of organic remains, so that we often want this evidence in this series. Mr. Sedgwick mentioned that Liverpool was seated on the *Grès bigarré*; and, although clay galls were often found in the rocks, it did not invalidate his opinion, as it has its beds of marl as well as the Keuper; even in old red sandstone in Scotland he had detected the galls. In answer to an observation of Mr. Greenough's, that there was a doubt respecting the coal sandstones, Mr. Sedgwick mentioned there were often strata of red sandstone mixed with the coal itself, and that there were many local peculiarities which might mislead an observer of England only; but, in comparing English geology with that of Europe, we must sink local distinctions, and endeavour to generalise our views. The same lower red sandstone, which is compact in Cumberland, becomes loose sand in Durham—and this anomaly would mislead a local observer, were the comparison not extended to the continent. It was stated by Dr. Lloyd, that he had found three teeth in the sandstone at Warwick—that he had examined attentively the formation supposed to be Keuper by Dr. Buckland, that he had observed alternations of marl and compact sandstone at different places, especially at Hartsill, where he had observed a limestone, also, that might be Muschelkalk; but he was unwilling to pronounce a decided opinion. Mr. Murchison did not consider this limestone as Muschelkalk, although he had observed a limestone at Broughton, in Shropshire, which corresponded in position, but, unfortunately, was deficient in organic remains. He conceived it still possible to determine accurately the distinction between Keuper and *Grès bigarré* without the presence of this rock, as in the south of France, where Dufresnoy had completely established the distinction. What Mr. Lloyd had observed, he conceived to belong to the portion called by the Germans *rothe todte liegende*. Mr. Stutchbury mentioned that he had examined the teeth discovered by Mr. Lloyd; and that, so far from referring them to the Keuper, he conceived they belonged to a stratum under even the *Grès bigarré*.

At the meeting of the Geological Section on Tuesday, the subject of diluvial accumulations received much attention, being prominently brought into notice by the following paper.

Mr. Strickland read a memoir on formations of gravel in the counties of Warwick and Worcester. He commenced by pointing out the great variety of gravel which is found in England, and its varied positions, it being found sometimes in the vicinity of the rocks from which it is derived—at others very far removed; in some places regularly stratified—in others forming outliers on the summits of hills. In some parts we find marine organic remains; in others bones of Mammalia and lacustrine shells. All these gravel formations are, however, unconformable to the beds on which they rest, and it is difficult to determine their age. The researches of Mr. Murchison were mentioned with great praise, in elucidating many points respecting the gravel of Wales and the adjoining counties; one point established being the existence, in former ages, of a marine current, from Cheshire to Gloucestershire, which had brought with it gravel in its course. The gravel formations described by Mr. Strickland, were divisible into two great portions, one being with flints, the other not containing any; and they occurred independent of the minor variations of the surface of the country—the one portion, that without flints being found to the north-west of the Warwickshire Avon, while the other portion occurs towards the oolitic hills; although, in all probability, they are of different epochs, it is not possible to determine their relative age, as no superposition has been observed. Along the oolitic hills there is also a deposit of local gravel, similar to beaches of shingle, as explained by Mr. Murchison in his description of certain similar phenomena near Shrewsbury. Mr. Strickland considers those portions of gravel that are spread over these countries as marine drift, and that gravel of a finer description, to which he attaches the name of fluviatile drift, may be observed in valleys, where it accommodates itself to the inequalities of the actual surface. In the marine drift no remains of any but marine animals are to be observed, whereas in the fluviatile we find the exuviæ of mammalia and fresh-water shells. A good example occurs in the valley of the Avon, from Rugby to Tewkesbury. Mr. Strickland suggested that further observations should be made upon the great marine drift, whether any point of junction can be determined of its two portions; also the existence in it of shells and bones, and the search, particularly for bones of Mammalia; and where fresh-water shells occur—its distance from rivers, and its greatest height above them.

Mr. Sedgwick observed, that it is difficult to generalize respecting these formations, as they presented so many variations. He had seen gravel on mountains 2000 feet high. Erratic blocks, he considered, could not be of fluviatile, but of marine origin, and organic remains of large animals were not likely to be abundant in gravel carried by currents of the sea, from the destruction caused by their violent action. Animal remains had been found in the clay gravel of the east of England; but this gravel he conceived as differing from that in other parts of the country.—Sir Philip Egerton said, that Mr. Strickland's flintless gravel, occurring to the north-west of the Avon, could be only a partial formation, as he had observed that in Cheshire the gravel always contained flint. At Cocknell he had obtained two grinders of an elephant, and many *marine* shells, and many like shells in other places, all of existing species, and occurring often with pieces of rolled coal.—Mr. Phillips stated, that one of the questions proposed by the Association, was the determination of the phenomena of the English gravel formations, but to the present time sufficient evidence had not been collected. He alluded to Mr. Murchison's opinions, that a strait formerly divided England from Wales; into this strait gravel might be drifted from both sides; and Mr. Murchison had discovered in Wales, local covered by erratic gravel. He himself had discovered in a valley of the Yorkshire Wolds at an elevation of 600 feet, gravel drifted from Cumberland, and containing bones of the elephant. He mentioned, also, the fresh-water gravel formation in the vale of York, in which Mr. Harcourt had caused sinkings to be made, and had found, at the depth of twenty-two feet, the bones of Mammalia along with fresh-water shells.—Mr. De la Beche spoke, also, of the difficulty of the question. On the Blackdown Hills he had observed a peculiar drift; on adjoining hills a drift of a different kind, and in the intervening valleys a mixture of the two, containing the bones of Mammalia.—Mr. Clarke also mentioned the difference of the gravel upon the plastic clay and the chalk of Dorsetshire. In that county he had observed two beds of gravel, one overlying the other.—Mr. Trimmer mentioned the occurrence of marine shells at an elevation of 1400 feet in Caernarvonshire; also of gravel at a lower elevation on limestone bored by shells.—Mr. Murchison stated his determination of the local gravel in the part of the country which he has termed Siluria; in this drift no shells are to be found. The drift from the north, he conceives must have been submarine, and that, in all places, it may have unequal distribution, from the unequal elevation of the subjacent land. He alluded to his communication at the Bristol meeting, respecting the elevation of Siluria at a different epoch from the other parts of Britain, as proved by the difference of the gravel formations.—The discussion respecting gravel was closed by Mr. Sedgwick. He had traced the gravel of the central parts of England to its northern sources; and he instanced a singular phenomenon of a mountain, near Buttermere, which appeared to be waterworn by a stream passing over it. The recent elevation of Siluria, he conceived, was proved by the morasses and lakes in its lines of valleys, which valleys, although shaped under the ocean, had been evidently modified by existing waters. He concluded by asserting, that all examination of nature, by means of accurately ascertained facts, must agree with moral or scriptural interpretation; and that we need have no fear as to the one clashing with the other, as truth cannot oppose truth, but must, in all cases, be coincident.

The Marquis Spineto made a communication respecting the Geology of the Desert between Suez and Cairo. In this desert travellers have always suffered great inconvenience from the want of water, and this was likely to prove a serious obstacle to the proposed communication by this route to India. In order to overcome the inconvenience, Mr. Briggs, the British Consul, employed a Swiss engineer to bore for water. Mr. Gensberg, the engineer, caused the first boring to be made in the Valley of Kejche, but being unsuccessful, he transferred his operations to the Valley of Candelli, where water was found in clay underlying a calcareous rock. Considerable ingenuity was shown in the excavation. Besides the usual boring downwards, lateral openings were made to increase the supply of water; borings were made in other situations, and very singular results obtained. A great variety of strata were penetrated, and this variety existed even within a limited distance of superficial extent; thus, in one place marine sand was found, and a little way off, terrestrial or desert sand: gravel occurred only in one spot. But the most singular geological phenomenon was the existence of granite over clay, in which good water was obtained. The Marquis mentioned that a notice of the intention of the British Consul to bore for water, appeared in the first volume of the "Journal of the Geographical Society," but that the communication now laid before the Section, was the first notification of the results obtained.

Mr. Horner exhibited to the Section a drawing representing some of the Geological phenomena in the neighbourhood of Christiania, in Norway, and read a letter from Mr. Lyell in explanation. This part of Europe received, some years ago, an examination from M. von Buch, and the results were at that time presented by him to the scientific world in such a manner, as to excite much attention, and to stagger many in their attachment to the Wernerian Theory, then very prevalent. Von Buch had discovered granite overlying fossiliferous strata outstepping the bounds prescribed to it by Werner, so that his disciples were obliged to invent a creation of it at a later date, to explain the Norwegian phenomena. Mr. Lyell has lately examined this interesting locality, and has found the junction of the granite with the fossiliferous rocks well determined; also that it not only sends veins into them, but that it actually in some degree overlaps them, the strata rather turning up from it. The granite sometimes became syenitic, passing into trap porphyry; and it has altered the appearance of the adjacent rocks, making them truly *metamorphic*. These fossiliferous rocks rest upon gneiss, and may be referred to the Silurian system of Murchison. The granite in the same vicinity comes in contact with the gneiss, which rock has frequently indications of having been disturbed before the deposition on it of the Silurian rocks, and it bears on its surface marks of scoring and abrasion. The posterior formation of the granite is proved by its veins in the adjacent rocks, and by the fragments of gneiss in the Silurian strata. The entire phenomena are of the highest interest—they must have been originally submarine, as the disturbances would have been greater, had they not taken place under a pressure of perhaps some miles of ocean in depth, and perhaps also with other strata upon them: the gneiss, under such a pressure, may have been only softened.

Near Christiana, many dykes, evidently of volcanic origin, also occur; these are of syenite passing into greenstone, and are evidently fissures filled with injected matter.

Mr. De la Beche observed, that it was now generally acknowledged that granite is of all ages, and that if it do not occur in dykes, its dome-shaped masses must manifestly have occasioned dislocations in the masses through which they were protruded.—Mr. Greenough was still unwilling to admit the igneous origin of granite as distinct from gneiss and mica slate; he conceived they must all have had the same origin, whether aqueous or igneous. —Mr. Clarke mentioned his having witnessed, in the department of Calvados, a direct passage of granite into gneiss, and thence into mica slate and clay slate.

The last communication was by Dr. Traill, "On some points of the Geology of Spain." At the Dublin meeting of the Association he had made some remarks on the same country. On the borders of Arragon he had observed oolitic rocks; new red sandstone also occurred there, covered in some spots by a conglomerate; near Saragossa gypsum is found with limestone; and in the same vicinity are tertiary formations. On approaching the Pyrenees from Catalonia, rounded pebbles occur in abundance, and at Barcelona are alluvial beds. At Montserrat he found clay slate, with conglomerate resting on it, succeeded by sandstone, dipping towards the valley containing the salt mines of Cordova described by Dr. T. in the "Geological Transactions." The Doctor exhibited a drawing of these mines, where the part already worked affords an escarpment of 400 feet of the purest salt, besides an under portion not yet touched. Near the Pyrenees he found veins of trap. On the Spanish side of these mountains, clay slate and limestone occur; on the French side clay slate only, while granite is found in the central portions.

The President called the attention of the Section to a collection of fossils from the mountain limestone, lying on the table, and which Mr. Gilbertson had left for inspection.

The proceedings of the Geological Section, on Wednesday, were highly interesting; the important subject of the origin and heaves of the mineral veins, or "lodes," of Cornwall being brought forward by Mr. Henwood, and exciting much attention and discussion, as will be seen by the following report:—

On the opening of the Section, Mr. Greenough exhibited a Geological Map of France, coloured by Messrs. Elie de Beaumont and Dufrénoy. Of this map only two copies have been finished; one for the French government, and the other had been sent over to be shown at the present meeting. The origin of this map was, the publication, several years ago of a Geological Map of England; at which time some French savans came to England to examine the plan of its execution. Mr. Greenough stated also, that in 1835, at the meeting of the German Association at Bonn, it was agreed that the scale of uniform colours should, for future maps of all countries, be left to the selection of British geologists.—Mr. Griffith mentioned that a new edition of Mr. Greenough's Geological map of England was in progress; and stated, that it is of the highest importance to establish, as soon as possible, an uniform scale of colouring.

Dr. Traill then came forward and stated, that as his communication yesterday on the Geology of Spain had been made near the close of the Section, he would recapitulate very briefly the sum of his observations, and range them in the following table:

Tertiary strata had been observed by him in Andalusia and Arragon.
Chalk—near Seville.
Oolite—in New Castile, Arragon, and Andalusia.
New red sandstone—in all these districts.
Mountain limestone—in the mountains of Andalusia and Valencia.
Old red sandstone—in Arragon and in the south of Andalusia.
Clay slate—in the Sierra Morena, Montserrat, Pyrenees, &c.
Mica slate—Sierra Nevada and Pyrenees.
Granite and gneiss—Galicia, Guadarrama, and Pyrenees.

The first regular communication of the day was from Mr. Henwood, "On some of the Phenomena of Mineral Veins in Cornwall." This gentleman has for several years examined these phenomena in that important mining district, often at great personal risk, and has from time to time communicated to the geological world many extraordinary facts which he had determined. He brought before the Section his present statement, in the shape merely of a question for solution, as important to the Cornish mining interest. In mines, veins are often heaved out of their regular course, and are traversed by cross-courses, causing farther irregularity. It was a desideratum of the first importance, that a law should be determined by which a heaved vein could again be discovered; and the opinion of geologists was requested on this point. In Cornwall, it is also the opinion among miners, that veins are of contemporaneous formation with the rocks containing them, which opinion is opposed to that of geologists in general, who consider veins, in most cases, as caused by disruption from mechanical force. Mr. Henwood exhibited a diagram of heaves in the mines of Dolcoath and Huel Prudence, which he submitted to the Section for solution by means of mechanical movement. He himself was inclined to consider the veins in these mines as of contemporaneous origin with the rocks in which they are found. The heaves he had ascertained to be in one and the same direction; and he conceived that, had they been caused by a mechanical force, they would be found in different directions.

Mr. Hopkins believed there was no difficulty in solving Mr. Henwood's question, by reference to the operations of mechanical force, but several data were necessary at the outset. He was fully aware of the difficulty of miners recovering lost veins, and that it was highly desirable to have rules laid down for doing so. He entered into a disquisition upon the formation of veins in general, and first stated the theories that had been proposed to account for them. One was that of the Cornish miners, as above stated. Another, that fissures in the rocks had taken place after their consolidation, which fissures had become filled subsequently with mineral matter; these fissures being either open cracks, or simply discontinuities of the strata. Mr. Hopkins referred to his paper in the "Transactions of the Cambridge Philosophical Society," where the subject was treated mathematically. He considered the idea of the contemporaneous origin of veins as having no claim to the name of a theory, from its assigning no physical cause—it does not even call in the aid of electric agency. Suppose even that a small mass of matter were acted on and modified by fire, it might present veins within it; but still no theory is assigned why these veins are so produced: here there is the action of fire, and consequently, after being acted on, the phenomenon may be regarded as effected by igneous agency;—yet how can this explanation be applied to sedimentary rocks?—to say, therefore, contemporaneous formation, is to use an unmeaning term. Suppose it may be ascribed to molecular attraction, still the cause is wanting; and although it might be of some avail in explaining the formation of globular masses, yet it is of no use in the present case, as we have to do with masses occurring in planes. In order to solve Mr. Henwood's question, we must know the angles which the veins make with each other, and also with the horizon, and the relative height of the strata on each side of the lines of dislocation. Mr. Hopkins considered that Cornwall was an unfavourable county for explainining these phenomena, as its rocks were generally unstratified; and he would prefer a county like Derbyshire, where the regularity of the stratification offered much facility in finding the necessary data.—Mr. De la Beche considered Cornwall as perfectly suited for explaining these phenomena on Mr. Hopkins's theory. In this county there exists a fossiliferous system, which has manifestly been upheaved by the granite, and is penetrated by the same granite veins which traverse the primary rocks.—Mr. Phillips said that we should not restrict the term contemporaneous, the real point urged by the Cornish miners being, that there was no displacement. Still we must seek for explanation in other districts. In these, the mechanical theory must be at once acknowledged to be true, when we see the disturbance in fossiliferous rocks, in some cases even in an intersection of their organic remains. But this theory ought not only to explain the direct phenomena, but must account for the exceptions; and in such cases, as in Cornwall, we must regard the structure of the rocks —their regular divisions and joints, which are independent of stratification —veins may even occur in these divisions. In the north of England, the contents of veins are found to vary according to the containing rocks; and he considers the circumstance of spar stuff occurring in the Cornish veins as not opposed to the idea of mechanical force, but as dependent upon electric agency.—Mr. Taylor, jun., stated, that in the course of his experience in practical mining, he had observed certain conditions necessary for the profitable working of metals. In the oldest, or scar limestone, he had observed that the miner was not remunerated; but in the newer lead-measures he had a better chance of success, as in grits and shales. The best chance was in altered rocks. In Cardiganshire he had observed a remarkable case in a slaty rock; where very schistose, the workings were poor; but where the rock was *diced*, as the workmen call it, they were certain to be rich: the strike of the altered rock being north and south, and that of the veins east and west. He had seen remarkable proofs of the mechanical theory in North Carolina, especially in the rich veins of iron ore of that country.—Mr. Sedgwick instanced the discussion now before the Section, as a proof of how much one branch of science was assisted by another: we here saw the application of Physics to Geology; he could record also the assistance rendered by Geology to Physics. This same Dolcoath mine, whose phenomena of veins were so singular, was the one selected by Prof. Airy for determining the density of the earth. Mr. Sedgwick remarked, that fissures caused by crystallization were, in general, very small; and that joints seldom coincided with rents;—that in districts where granite approaches slate rocks, we may be certain of finding the richest metalliferous deposits. Practical miners had often whimsical ideas of the origin of metals. One of them had once gravely informed him that they were caused by *peat*, and had shown what he conceived to be a convincing proof, viz., their existence under a peat bog in his neighbourhood, an occurrence nowhere else in the same vicinity.—Sir W. R. Hamilton testified also to the importance of new applications of mathematico-physical science. Not only would new views open, but even new methods of analysis would arise to assist the investigator.

Dr. W. H. Crook made some observations on the unity of the Coal Deposits of England. The object of this communication was to show that the coal-fields of England and Wales were not *distinct* basins, but that the supposed basins were only portions, which had been detached and elevated by the agency of sienitic and trap rocks, of a much larger deposit, spread over the greater part of the districts now covered by the new red sandstone. Of the vegetable origin of coal there is now no doubt: the only question unsetttled is, did the plants supplying it grow on the spots where it is found, or were they transported? Dr. Crook inclined to the latter opinion, and conceives that this view may be extended to the coal of Belgium, of the north of France, and the north-west of Germany; the carboniferous beds of those countries having originated, in his opinion, in a drift of vegetable substances from countries lying to the east or E.S.E. of them; and he also thought, that the extent and richness of the English coal-fields, especially in the Midland counties, arose in a considerable degree, from the impediments offered to the transit of the drifted matter by the slate and other ancient formations of Wales and Cumberland. He considered that the Charnwood Forest rocks had elevated the coal-field near it, and a similar elevation had taken place at Nuneaton.

Mr. Greenough considered the idea of Dr. Crook as very probable; but observed, that the deepest of our coal basins has been found to be in South Wales.—Mr. Young, from Nova Scotia, stated, that large deposits of coal had been found in that country.

Mr. Sedgwick requested the attention of the meeting to an account, which he was about to submit, of the late unfortunate accident at the Workington Collieries. He pointed out, on the geological map, the rocks which occur in that neighbourhood, and stated some of the phenomena of the stratification of the coal measures, which are there very much disturbed. There is an anticlinal line, on the opposite sides of which the strata dip differently, so that, in one place, very important beds of coal crop out under the sea. Workings, quite submarine, have accordingly been carried on for some time: in the Isabella pit, a depth of 135 fathoms under high water has been reached. A culpable want of caution has been shown by the managers of late, as they have caused the workings to reach too near the sea—even within fourteen fathoms of it; and the pillars and roof of the older works had been taken away, by which the danger was greatly increased. There had been repeated warnings from the shrinking of the ground, and from an old work having become filled with water; also in the new workings, although the pumping brought up 1000 gallons per minute, the miners were in such danger of being drowned, that several left the employment. In the latter end of July the sea at length broke in, filling the mine in all its parts, in little more than two hours, and destroying twenty miles of railway. On one side of the Camperdown dyke, which ranges through the mine, not a soul was saved, but several escaped from other parts; and one individual, an Irishman, called Brennagh, had not only a remarkable escape himself, but saved three others by his intrepidity. Professor Sedgwick related to the Section this man's story, which was so singular, and told with such a mixture of the serious and ludicrous—often in the language of the man himself—that it is impossible to convey to the reader an idea of the effect produced on the audience. A remarkable fact in the escape of one of the individuals rescued by Brennagh was, that he was actually *blown* up the last open shaft of the mine by the enormous force of the air, the noise of which was heard at a considerable distance in the country. The first notice to Brennagh of the accident, was an unusual undulation of air in the galleries, which made him suspect that all was not right, and he took the precaution of moving near to an air-passage in the dyke, which he had been permitted to use: he was thus enabled to save himself and his companions. At the suggestion of the Professor, a subscription was made in the Section for Brennagh, which amounted to 34*l*.

Specimens from the bone cave of Cefn, in Denbighshire, and from the Ludlow rock, were exhibited.

The proceedings of the Geological Section, on Thursday, had chiefly reference to the important subject of our coal deposits, and the faults and dislocations which are observed to traverse them.

Mr. James Heywood submitted a communication on the coal-field of South Lancashire, occupying a space of about 250 square miles. This great deposit of coal is partially concealed by deep mosses and beds of gravel, sand, and marl. On the eastern side of Lancashire, a range of gritstone hills forms a well defined boundary. From the steep acclivities above Todmorden, a transverse ridge of similar hills breaks into the central portion of the carboniferous district, and separates the southern from the northern part—among these hills, however, are isolated beds of coal. In the northern portion, the coal strata are found in the shape of a basin, whose outer edges rest upon gritstone: in the centre of this basin, the inclination of the coal is very trifling, but at Blackburn this inclination becomes greater. On the western boundary, the red sandstone is associated with beds of marl, often very thick, and this boundary may be traced by Mawdsley, Newburgh, and Blague Gate, to Stanby Gate and Bickerstaff; at Blague Gate the coal being inclined towards the south-east, at Bickerstaff, towards the west. Coals are found at a moderate distance under the surface, from twenty to seventy yards, generally under the red marl, although near Prescot hazles overlie them; north of that town they are cut off by a large mass of sandstone. A long promontory of the same rock also stretches out to the north-west of Manchester, as far as Ringley Bridge, and bounded on its north-western side by an enormous fault of 1000 yards, downcast to the east—this may be seen between Clifton and Ringley. On the western side of this fault, the cold sandstones dip 10° to the south-south-west, and on the eastern side they are almost horizontal, the interval being filled up with a collection of rectangular prisms of the sandstone. On the south-western side of Manchester, the new red sandstone may be traced along the Irwell, and then on the Mersey. On the north-east side of Manchester, coal is found in various places; the red rock intervenes at Bank Bridge, on the eastern side of Bradford; afterwards the coal continues to the gritstone boundary of the district. Limestone is found at Whiston, on the south side of the Liverpool and Manchester Railway. Magnesian limestone occurs at Bedford, nine miles west of Manchester, dipping conformably to the new red sandstone. Coal is worked very near this, and it may probably extend under the magnesian limestone. Carboniferous limestone is to be seen at Ardwick, alternating with shales, and dipping south-west, conformable to the other beds. Generally speaking, the coal strata east of Manchester, under the gritstone, dip to the west, and to the north their dip is towards the east—the highest mines being found near Manchester, and the lowest towards the gritstone hills. The red rock fault of the Irwell causes a singular phenomenon of the position of the strata, the low mines being found on its west side, while to the eastward the high mines again begin; there are also other faults parallel to this in their direction, which is north-north-west. An anticlinal line is formed by a fault near Heywood, in which the sandstone dips 5° to the south-west below the fault, and 10° to the south-east above it. The levels of the coal strata are usually cut off by the principal faults at an acute angle, so as to give to the horizontal section of the coal-field, the appearance of an assemblage of rhomboidal prisms.

Mr. Williamson then explained to the meeting a drawing of sections of the Lancashire coal district. He does not describe the strata as they occur in a direct perpendicular descent, but, commencing at a particular point on the surface, he records those beds that are found to where a fault takes place; he traces this fault as far as it extends, and then describes the strata that succeed, until he meets with a second fault, then another set of beds, and so on. He gave a number of valuable remarks on several of the strata. After mentioning the well-known saliferous rocks, he noted the almost total absence of the magnesian limestone—so important a member in the north of England. He mentioned the lower red sandstone that underlies this, and the singular limestones near Manchester, containing fresh-water shells, which were described by Professor Phillips, at the Bristol Meeting of the Association. He exhibited a number of beautiful drawings of organic remains, some of which are very singular: including vegetable fossils, teeth of Sauroid fish; but the most interesting were of fossil fish, which Mr. Williamson conceived to have a close resemblance to the recent salmon. In mentioning the coal strata of Wigan, he pointed out a remarkable seam of impure cannel under the Smith's coal, which seam contains fresh-water shells. Some of his drawings represented *Goniatites* and *Pecten papyraceus*. He thought it very likely, along with some other geologists that the different coal basins of England, are parts of a great whole. He showed drawings of fish scales found in the coal strata. These have a close resemblance to the scales of recent fresh-water fish, and form an additional argument in favour of the formation of coal beds originally in fresh-water lakes or estuaries—perhaps the latter, as he found also some shells, evidently marine.

Mr. Williamson was succeeded by Mr. Pease, who exhibited a map, on which were marked lines, representing the dislocations in the coal-field of Wigan. He divided them into two kinds, main faults and cross faults, the latter of which sometimes run out. The lines upon the map had a singular appearance of regularity, and are valuable data for such geologists as Mr. Hopkins, who applies the powers of mathematical science to elucidate geological phenomena. Mr. Pease also exhibited some specimens of coal, in which the fibres very visibly assume a determined direction; they point from north 15° west to north 25° west.

Mr. Logan made a number of observations on the coal basin of South Wales. He remarked the very extraordinary parallelism of the faults of this district, which uniformly assume a magnetic north and south direction, coinciding, also, with the jointed structure of the rocks. It is usual, before coming to a master fault, to meet with one or more smaller ones, parallel to it, and throwing the measures up and down in the same direction. These master faults appear, in general, to run across the whole basin, and to extend into the old red sandstone. Minor faults occasionally branch from the large ones, and perhaps, in some instances, two very considerable faults merge into one: in this case, both the faults seem to throw the measures the same way. The measures often dip differently on the opposite sides of a fault; and faults often diminish towards their extremities. They are seldom quite perpendicular, and their dip or underlie is generally towards the downthrow; and hence a portion of strata between any two would assume the form of a wedge—and no working has penetrated to the bottom of these wedges. The faults are of various breadths, from a few inches to many yards. The coal on one side of a fault is often different from that on the other side—that on the upthrow side frequently containing a smaller quantity of bitumen. On the north-west side of this coal basin, the non-bituminous, or stone-coal, occurs, and the bituminous towards the south-east; the region between contains coal of an intermediate quality. Mr. Logan considers the change of quality as caused by internal heat. He mentioned two anticlinal lines, one running from Pont ar Dawe to Rhyd y Mardi, the other from Loughor to Swansea. In the mountain limestone, to the east of Cefn Bryn, are two waves or ridges, running east and west. The millstone grit appears above the limestone, along the northern rim of the basin, and at Llanrhedian on the southern side, near which locality wavellite also occurs.

Mr. Sedgwick having stated that he would now receive the observations of any one present upon these several papers on the coal strata, Mr. Phillips came forward, and spoke of the regularity of the fibrous structure of coal, as forming an important cause of its cleavage; this regularity of cleavage enabling the practical miner to work it with more facility. He referred to the two kinds of faults depicted on Mr. Pease's map, and pointed out that the lesser are often swallowed up by the greater, and that the two kinds do not cross each other at right angles. He made a remark on the law of dislocation of stratified matter, the plains of fissure having often their inclination in the same direction as the beds thrown down.—Mr. Hopkins said, there were two questions relating to the lines on Mr. Pease's map; were they the consequence of the structure of the mass, or were they caused by external force? He conceived the structure of the mass to be an independent circumstance, but that external force might be modified by it; the direction of the planes of dislocation depends upon circumstances, but he conceived that intersecting forces will be found to be at right angles. Between the geological features of a district, and the planes of dislocation, there must be a coincidence; and he had observed, that in cases of metallic veins their inclination was greater than that of beds of coal. He praised the correctness of Mr. Pease's determination of these lines of dislocation: and, had that gentleman mentioned also the lines of basset, the chief elements of calculation would have been supplied.—Sir Philip Egerton was requested by the President to give his opinion respecting the fish, supposed by Mr. Williamson to resemble the recent salmon; Sir Philip referred to the arrangement of fish proposed by M. Agassiz, and to their geological distribution. The salmon is ranged by that eminent naturalist under the division of Cycloidal fish, and remains of these have not been discovered in any system below that of the chalk. The fish delineated by Mr. Williamson might be referred to the genus Colopticus, and the teeth to *Diplodus gibbosus*.—Dr. W. Smith remarked, that the specimens of coal exhibited by Mr. Pease would point out a mode by which coal could be touched without dirtying the fingers, what are technically called the top and bottom being the soiling sides, but the cross cleft is clean.—The President said, it was a thin layer of mineral charcoal that caused the soiling. He again spoke of the uncertainty of the lower red sandstone, instancing a very old member of the series, discovered in Lancashire by Dr. Smith. He alluded to the value of coal strata in geological sections, as being good geological constants, or base lines to work from, in investigations of different phenomena. He spoke also of the fears of exhausting our coal mines; he conceived there was as much coal already discovered as would last for a very long period, and in the mean time more might be found; besides, in the process of discovery, which of late has made such extraordinary strides, some new mode of producing heat may be employed.

The proceedings of this day were closed by some observations from Mr. Smith, of Jordan-hill, on the changes of relative level of land and sea, as demonstrated by raised beaches, and by a communication from Captain Portlock, on the new red sandstone in Ireland, which, however, do not require further notice here.

At the meeting of the Section of Geology and Geography, on Friday, Mr. Dawson exhibited a collection of fossils from New South Wales, and a communication of considerable length was made by the Rev. D. Williams, on the ancient secondary slate of Devonshire, to the fossils and classification of which he has given much attention.

Mr. Murchison communicated some information which he had lately received from M. Agassiz, who was bringing out some new livraisons of his great work on fossil fishes, and he mentioned that, in order to enable that gentleman to carry on his work, a further grant of money would be recommended by the Geological Committee. The remains of fish had been found to be the most valuable of all indexes for determining the ages of rocks, as there was a plain separation of these animals in formations of different ages. Mr. Murchison showed drawings of some of these fossils, and remarked, that in the lias and the older beds the fishes were characterised by a tail quite different from that belonging to those found in the newer formations, and he exhibited on a board representations of some of the peculiarities of those discovered in the Silurian rocks. He must record the names of Drs. Lloyd and Lewis as having given him material assistance in the collection of these remains. He had found remains like the shagreen or tuberculated skin of some recent fishes, also extraordinary teeth belonging to a species termed *Stogodus Priscodontus*, and fish called *Seraphim* by the quarrymen, from their seeming to possess only head and wings, to which the name *Pterigodus* has been given; also many others which M. Agassiz would soon have described and published.

Mr. Griffith directed the attention of the meeting to a section of a district in Ireland, from Butler's-bridge, in the county of Cavan, to Benbulben, in the county of Sligo. This section passes through a part of the Connaught coal district, and possesses some interesting phenomena, besides having the merit of great accuracy, being made after the Ordnance Trigonometrical Survey had been completed. After detailing a few of the geological features of Ireland, which had been previously, at the Dublin meeting, described at full length, Mr. Griffith pointed out that above the old red sandstone we find a yellowish sandstone, alternating with coal strata; at Butler's-bridge, where the greywacke attains an elevation of 180 feet, we have an anticlinal line; here sandstone alternates with mountain limestone, which, at Belturbet, is 400 to 500 feet thick: to this succeeds a series of impure shales and a blackish limestone, called calp by Kirwan; these extend to Sliable Rushan, and are succeeded by another bed of limestone, equivalent to the great scar limestone of England, and, like it, containing many caverns which do not occur in the under or first-mentioned limestone; it is from 460 to 500 feet in thickness in this place. It undulates in the valley of Swadlinbar, and goes under the mountain of Culkeagh, where the source of the river Shannon is at an elevation of 298 feet above the sea. Continuing the line of section, we pass through part of the coal formation of Leitrim and Sligo; we find granite at Benbo mountain, 1365 feet in elevation; around this are primary slates, hornblende slates, and steatite enclosing garnets; on the other side of Benbo we again come on the mountain limestone, which extends to Benbulben, underlying shale and sandstone; above these we find the great shale, containing shells of the genus Posidonia; several other beds of shale are found in ascending in the scale. At Lugacaille, across the valley of Swadlinbar, a rock-like millstone-grit forms the mountain cap; this contains remains of Stigmaria; coal of an impure quality extends to Lackugh mountain. In all the shales the shell posidonia occurs, as well as a great variety of other fossils, all of a very small size. Sir Philip Egerton stated that his first study of geology was in this district; he had there remarked that the sandstone between the shales contained no organic remains, and but for their absence, it would have been classed with a sandstone quite distinct. Mr. Greenough stated also that these lower shales and impure limestone had not been sufficiently examined in England, and recommended further investigation. Mr. Sedgwick spoke of the difference of the coal phenomena of England and of Ireland: in the latter country the coal strata generally occur under the millstone grit, whereas, in England, the most valuable beds are found above it. He conceived it difficult to make divisions in carboniferous limestone according to its fossils, the accumulation of fossils depending upon adventitious circumstances. A particular kind of animal life may characterise a formation, but within the boundaries of that formation there can be no modifications but what are caused by local agency; animals living in the muddy bottom of a sea must differ from those inhabiting a sandy bottom, so that it becomes difficult to give an exact determination to separate beds of a formation by their fossils.

The Rev. D. Williams exhibited a section of part of Devonshire, and read a paper "On some Fossil Wood and Plants recently discovered in a series of rock far below the culm field of Devonshire, being one of the results of an attempt to determine the relative age and order of its anthracite and floriferous shales and sandstones." As the meeting was pressed for time, he read only the more important parts of his memoir.

Mr. Williams commenced by stating, that he produced the specimens of fossil wood and plants, in compliance with a recommendation of the Com-

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mittee of the Geological Section of last year. In the summer of 1835 he had taken many of the upper culm plants to the meeting of the British Association at Dublin, but beyond the fact (which he then stated) of their occurring in a deep trough, bounded by the ridge of Exmoor on the north, and the granite of Dartmoor, and the quartz slates of Forrabury and Boscastle on the south, he knew nothing, and, in consequence, determined to commence a careful and critical analysis of the structure of that interesting section of the great grauwackè group.

The Exmoor and Quantock group was of such perfectly simple structure as to be briefly explained by *a series of successive emergence*—the key to unlocking it being found in the fact that the lowest and most ancient emerged at and towards the north-east; thus, in the ascending order, the Cannington-park limestone, near Bridgewater, was the lowest rock of all, rising immediately from beneath a low ridge of red, compact, and sometimes confluent sandstone and shale.

The Morte quartz and roofing slate was the most extended and thickest of any—it constituted the South and S.E. angle of the granite of Lundy Island—it was intersected by a dyke of syenite and freestone porphyry in the Quantocks; and, in the southern terms of the great trough, by whatever synonym it might be distinguished there, was intimately associated with the elvans and granite of Cornwall; it was characterised on either hand by great amorphous masses of quartz, spangled with flakes of mica, which, protruding in snow white masses on the surface, were very serviceable to the geologist to enable him to determine his whereabout amid the black waste and morass of Exmoor.

Having stated that the Wollacomb sand and flag stones contained, in their upper division, calcareous courses producing orthoceratites, producta, &c., in common with the fossil wood and plants exhibited, and that they distinctly dipped away below the trilobite slates, which, making all allowances for angle of dip, inflexions, and undulations, averaged nearly a mile and a half in true diameter—he proceeded to discuss the disputed question of the relative age of the culm-field and its floriferous shales and sandstones. Did those trilobite slates then pass into the wavellite limestones and schistus? He confidently believed they did. He believed they did at Sticklepath Hill, immediately west of Barnstaple; and when he had made out the (to him) extraordinary faults which dislocated the region to the east and west of Barnstaple, he felt assured he should be able to show equally or more conclusive instances, which (inasmuch as those limestones and shales contained plants) would alone afford tolerably conclusive evidence of the relative age of the culm-field. The faults alluded to were not the traps up and traps down he had hitherto been accustomed to, but true horizontal faults, the trilobite slates and wavellite schistus respectively interlocking and dovetailing into each other; a result probably of the exertion of the enormous lateral force which had frilled and puckerred the shales and sandstones of the culm-field into such strange contortions—those contortions, however, he thought might be explained and expressed as closely compressed undulations, the entire class of phenomena probably caused by the intrusion into the culm-field of the granite of Dartmoor.

So far as organic fossils were concerned, there was a great hiatus between the trilobite slates and the wavellite limestones, but the discrepancy was no greater in this respect than between the Wollacomb sandstones, or between the wavellite limestones and the sandstones and shales of the culm-field—and this, admitting that organic fossils had any authority in determining the question of the geological age of the culm-field and its flora, which he emphatically averred, so far as they were yet known, they had not—all that the fossils of Devon could be adduced to prove distinctly, was the fact of the mountain limestone being the last or newest formation of that stupendous system, the grauwackè or transition. The goniatites and orthoceratites, together with posidonia, and other bivalves, therefore proved nothing unless it could be shown that they made their appearance *first* in, and were exclusively restricted to, the mountain limestone—and if these few and far between reliquiæ of the wavellite limestones should be appealed to, to establish their identity with the great upper carboniferous limestone, he was prepared with evidences infinitely more varied and abundant from the Cannington Park limestone, ten miles in true vertical depth below it, to show the same apparent identity. The same might be said of the Doddington limestones—of the Linton slates and limestones—of the limestone of Ilfracomb—to a less extent of the upper beds of the Wollacomb sandstones, where lepidodendron, bothrodendron, and stigmaria (all true coal plants), place them in the same category—and of the trilobite slates—but where, he asks, must we include the wavellite limestones, if we only regard the organic remains of the mountain limestone, which are absent? He would, for instance, adopt the synonym of the latter—viz., "the encrinal limestone," and we have the anomaly of its Devonshire equivalent not possessing a single encrinite; added to these considerations, he appealed to the improbability of some twenty or thirty insignificant beds of limestone, representing the great carboniferous formation, which extends in such imposing force and importance from the Scottish border to the Land's End of Wales and Ireland. He objected also to the barren tract in Pembroke being admitted as a case in point, to fortify this hypothesis—that barren tract being included in well-defined terms of the mountain limestone, while the culm-field of Devon is not. These several considerations, supported as they are by the collateral and positive testimony of the fossil wood and plants from the Wollacomb sandstones, throw such accumulated weight into the scale of the opposite hypothesis, viz., that the anthracite of Devon and its flora belong at least to the upper grauwackè (below the old red sandstone), that he apprehends geologists ought to include them provisionally as such, till stronger facts and evidences than we are yet in possession of, shall justify accepting them as a true cotemporaneous equivalent for the carboniferous limestone and the upper great coal-field.

Mr. Murchison differed in opinion; the passage of these culm strata downwards was wanting, or the proof that they form a regular coal basin would be complete; indeed, he conceived it impossible to place these beds in the Silurian system, as with them are found shells evidently of the regular carboniferous formation. On the opposite coast of Pembrokeshire we find a coal basin of very similar character.—Mr. Greenough was inclined to adopt the views of Mr. De la Beche. We must be guided by analogy with other countries where similar phenomena occur; foreign geologists could not distinguish any separation in the plants found in the coal strata from those of transition rocks.—Mr. Sedgwick mentioned that when Devonshire had been first mapped, these culm strata were coloured as grauwackè, and as *lower* than the other rocks of the county. By connecting Devon with Cornwall he had been enabled to detect this original mistake. These culm strata did not rest upon the mountain limestone, as in the north of England, and a hiatus in the evidence consequently results; there might be even a cause of error in the fact of some of the silurian calcareous beds being rich in fossils, but he had found one which differed from the rest in its organic remains. He should be inclined to consider the base of the culm measures to lie under the carboniferous limestone in the order of succession, but he was sceptical respecting the evidence supplied by plants, as there was some confusion in determining their species. Were remains of fish to be procured, the question could be easier settled.

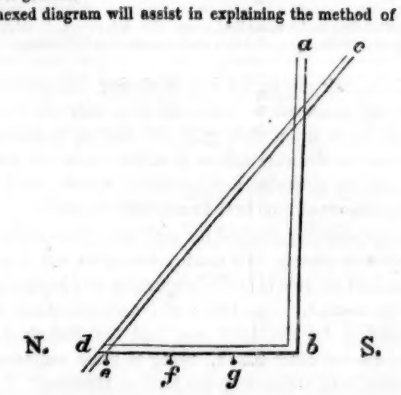
Mr. Hopkins made a communication "On the Refrigeration of the Earth."—This gentleman has distinguished himself by the application of mathematical and physical science to Geology, and in the present case has made use of a number of geological facts on which to found calculations of a very intricate nature. He commenced by observing, that it is requisite to make some hypothesis before we enter on investigation; and if we discover that the result of observations coincide with an hypothesis, we may consider that to be pretty near the truth. Were we able to apply a thermometer to every part of our globe, both externally and internally, we should multiply very much our means of ascertaining a number of facts connected with its temperature; but as this cannot be accomplished, we must endeavour to employ whatever evidence may lie within our reach. Let us then, he continued, suppose a globe to be heated; of this there may be two cases, one the simultaneous uniform raised temperature of the mass—the other, heat applied to it in one part and afterwards diffused through it by degrees; the question then is, what is the temperature at any subsequent time, and can this be a matter of calculation? if so, we must try if our calculations agree with experiments. If we suppose that our globe was originally hot to the degree of fluidity, and even to look for proofs in its present condition, the first that would strike us would be the spheroidal shape, caused by the rotation of a fluid mass round an axis, and this can be submitted to mathematical calculation, and be readily confirmed by actual experiment. The next proof is the peculiar constitution of the earth's crust, which we find in many places bearing the marks of dislocation, with irrupted matter intruded, exemplified by dykes of trap, and inclining us to suppose that there is a solid crust resting above something fluid below. Mr. Hopkins here contended, that we must not take the Mosaic account of the creation in its generally accepted sense, as the usually allowed age of the earth was too short for the completion of these phenomena; and that we were by no means trenching on the domain of true religion by reasoning thus, but simply making use of the evidence afforded us by the Deity in nature itself, and by the exercise of our powers of induction. All must now be fully aware of the great time required for the developement of geological phenomena, the greater part of which long preceded the creation of man. Mr. Hopkins then stated that all natural phenomena must arise from natural causes, whether these be the regular physical causes always in exercise, or the interferences of creative power, as in the case of miracles. The view of present geological phenomena might suggest the idea of a permanence of natural causes; still there might not be a permanency of condition, and without this we cannot conceive a permanency of action. If the earth be conceived to have been originally a hot fluid mass, it may have cooled in the manner of a fluid in a vessel, the upper part first losing its heat, and then descending by its gravity so as to cause a constant circulation. Two antagonist forces must be now taken into account—the heat and the pressure. The greater the heat of the mass the slower will be the solidification, but this latter increases as the pressure. When the temperature at the surface is least, the pressure is least, but is greatest when the temperature at the centre is a maximum; we must, therefore, know the relation between the tendency of the pressure to promote solidification and that of the temperature to resist it.

If we suppose the earth to have cooled first at its surface, there would be a consequent increase of superficial density, but still the ceasing of circulation implies a ceasing throughout the entire mass. Some philosophers have urged the impossibility of a heated centre now existing, as that would imply the actual existence of a circulation which cannot now be going forward. Suppose another case, that the earth cooled first at the centre, and the cooling proceeded upwards, then we should have a solid centre and a fluid superficies; or suppose another condition, that, after a solidification of the central parts, the surface became hard, we should then have a fluid band between the centre and the superficies. The present state of our knowledge does not enable us to decide which of these cases actually exists or has existed. We are aware of the increase of temperature ascertained by experiments in mines: we are as yet unable to assign a cause for this. M. Poisson cannot conceive that there can be an increase of heat at the earth's centre, as that would cause an expansion, of which we have no proof; and he has brought forward some other objections and opinions which have been discussed by Mr. Whewell. Although our data are thus far trifling, we find that all our calculations and experiments lead us back to a contemplation of the earth's original fluidity.—Mr. Phillips spoke in commendation of the talent and ingenuity of Mr. Hopkins in bringing to the aid of geological science the subtle powers of mathematics, which will eventually place it in the same rank with other exact sciences. Mr. Whewell stated that Mr. Hopkins had not mentioned to the meeting some of the most recondite parts of his investigations, which, when completed, would astonish the scientific world. He was employed in calculations of the disturbances produced on the earth by the sun and moon, on the supposition of its possessing at different times certain states or proportions of fluidity, and then to ascertain if the results will agree with actual phenomena. Mr. Sedgwick mentioned the proofs we have of internal action in the earth, from the crystalline nature of some of its mineral masses, and from the perturbations of the surface continually going forward in the cases of earthquakes, leading us to suppose that this surface is the cover of a series of vaults.

The concluding meeting of the Geological Section was held on Saturday, when the subject which chiefly occupied attention, was a communication from R. W. Fox, Esq., on the "Electrical Phenomena of Mineral Veins." We have been favoured with the following report of Mr. Fox's paper:—

Mr. R. W. Fox, having been requested by the British Association, at the meeting at Bristol, to make some experiments on the electricity of metallic veins, and the temperature of mines, stated, that his only recent experiments on the electricity of metallic veins, were made in Skeers and Coldberry lead mines; the former in limestone, and the latter in sandstone. The metalliferous veins in both mines have nearly an east and west bearing, and those in the former are dislocated by a cross vein, containing lead, at some distance from the points of intersection. Having connected a portion of lead in the latter with some in the former, by means of copper wires, the galvanometer was very feebly acted upon, and indicated a tendency in the electricity to pass from the north to the south in the cross vein. In Coldberry mine, he could not perceive any decided evidence of electrical action between portions of ore in an east and west vein. He referred to the absence of electrical action which he formerly noticed in some lead mines in Flintshire, situated in limestone, and thought that it might be connected with the fact, that galena is less electro-magnetic than the sulphurets of copper and iron. Mr. Fox, moreover, referred to experiments which he had made on some specimens of the cinder or charred coal, taken from the coal beds contiguous to the great basaltic dyke in Durham, by which it appeared, that, like coal and anthracite, they were incapable of conducting voltaic electricity, although the cinder, or rather coke, taken from a common fire, is a very good conductor. (He has since stated, however, that one of the specimens sent him from the colliery, possesses the conducting power, a fact which identifies it, by this test, with charred coal; and it does not clearly appear why this property is wanting in other pieces, which quite resemble coke). With regard to the temperature of mines, Mr. Fox referred to his opinion long ago expressed, that the extraneous cooling processes, at the lowest excavations of deep mines, are more influential than the heating ones; and he mentioned some experiments, which had been made at his request by the agents of Consols Copper Mine, in Gwennapp parish, and of Levant Copper and Tin Mine, in St. Just parish, near Cape Cornwall. In each mine two thermometers were used, one small and the other four feet in length. The former had its bulb buried about one inch in the rock, and the latter, near it, three feet deep, and closed round with clay. Under these circumstances, the deeper hole, three feet below the bottom level in Levant mine, and about four feet from the lode, was found to be at 80°, and the shorter one at 78½°, after allowing for errors of graduation. The depth of the station from the sea level is 200 fathoms, and about 230 fathoms from the surface, and the rock there is granite.

The annexed diagram will assist in explaining the method of making the



experiments in Consols. Let *a b* represent the deepest part of Pearce's shaft, *b* being 290 fathoms below the surface, and 237 fathoms under the sea level, half tide, the level *b d*, which is a *cross-cut* at right angles to the bearing of the lode, being at the depth. The thermometers were placed, the smaller one an inch deep, and the longer one three feet deep, in holes at *e*, *f*, and *g*, in succession, and left some hours at each station, *e* being in the lode *f* ten fathoms, and *g* twenty-four fathoms to the southward of it, and all in killas. The deep hole (*e*) in the lode, was found to be at 92° of temperature, and the one-inch hole near it at 88°. At *f*, the deep hole was at 86½°, and other at 85°; and at *g* the former was 85½°, and the latter 84°. Thus it seems that the temperature of the lode was 5½° warmer than the rock at the distance of ten fathoms, and 6½° more so than at twenty-four fathoms from it, and the deeper hole of three feet was 1½° warmer than the shallow hole of one inch. The ratio of increase at *g* is about 1° for every forty-nine feet in depth, and at Levant mine, 1° in forty-six feet, if the calculation be made from the surface, and it be considered uniform, which, however, is not likely to be correct. On the contrary, it may be considered that there are local causes which produce anomalies in the rates of increase, the chief of which Mr. Fox supposed to be the tendency which warm water has to ascend through colder portions of that fluid, so that the heat he conceives to be rather *carried* than *conducted* upwards, in a greater or less degree, according to the facilities afforded; and to this modifying cause of temperature, he refers the usually higher temperature of lodes, as compared with the containing rocks, and of slate in reference to granite, and, moreover, the ascending of thermal springs through faults.

When the above discussion had been concluded, Mr. Hall exhibited a Geological Map of Derbyshire, and pointed out the different strata.

He conceives there are four different beds of limestone, and three of [illegible] stone; in the northern part of the limestone field the veins of lead [illegible] from magnetic N.N.E. to S.S.W., and in the southern, in a direction almost at right angles to this. The Derbyshire coal-field lies upon millstone grit.

Mr. Barker stated, that late observations of Mr. Hopkins had proved that the three beds of toadstone were merely parts of one bed, which had been dislocated; and that, in consequence of the suggestions of that gentleman, a new mine had been lately opened, since the new light which he had thrown upon the structure of that country. The only case of a second toadstone, was near Bakewell.—Mr. Sedgwick considered that the toadstones are tabular volcanic masses; he praised the labours of Mr. Hall, who had been a pioneer in geological investigations, and who had furnished most valuable information to Mr. Farey, when drawing up his memoir on Derbyshire.

Mr. Clarke had a communication to lay before the meeting, on the Plastic Clay of Dorsetshire; but, as the time was nearly spent, he made only a few observations. He mentioned the existence of systems of valleys which have been caused by a regular disturbing force: there seemed to be three systems almost perpendicular to each other, which were manifest illustrations of the theory of of Mr. Hopkins. In these valleys were found rivers—the Wiltshire Avon, for example—which, although modifying their beds from time to time, were not the causes, but the effects of these valleys. Some cliffs on the sea shore, which Mr. Lyell had examined, and which contained fissures, ascribed by that gentleman to the action of water, had evidently been subjected to a disturbed force, which had been the cause of these rents. Mr. Clarke related, also, the increase of the bar at Poole Harbour, and the probability of its eventually stopping the navigation, unless the wearing away of certain chalk cliffs caused an alteration in the channels. He exhibited specimens of fossil wood penetrated by shells, which were found in the plastic clay; and stated, that the gravel of Dorsetshire had been drifted from the westward; he had been able to trace fragments of oolite to that formation at Bridport, as well as boulders from the rocks of Devon and Cornwall.

The business of the Section ended with a paper from Mr. Hardman Phillips, "On the Anthracite Formation of Pennsylvania."—This formation occupies a space of 200 miles long, by about 30 broad, having its beds often cropping out above the level of the running waters of the country. These beds are from four to nine feet in thickness, and the coal has a specific gravity of 1·279, containing 22½ per cent. of volatile matter. Its dip is generally very trifling, being one inch in a yard, so that it is easily worked by lead drifts; in one place, however, there is a greater dip, it there forming an angle of about thirty degrees. It is used in the iron manufactures of Pittsburg, but for smelting the ore the miners prefer charcoal.

Having now selected all the most important communications relative to the iron manufacture in our former Supplement, and those on geological subjects in our present, we shall conclude our report by a few selections of a miscellaneous nature, from the different Sections, commencing with the following:—

A paper, by Mr. Golding Bird, was read to the Chemical Section, on Monday, "On the Crystallization of Metals by Galvanic Influence.

To this department of knowledge popular attention has been peculiarly attracted by the well-known experiments of Mr. Crosse, detailed at the last meeting of the British Association at Bristol; and it is in connexion with this gentleman's experiments that the present paper is more particularly interesting. It has long been a matter of extreme interest and importance to connect those changes constantly going on in the physical world with those which are observed in the laboratory of the chemist—to compare the researches of the experimental philosopher with the effects everywhere produced in the vast amphitheatre of nature. With this view the experiments about to be detailed were undertaken. Philosophers have long been accustomed to attribute the formation and crystallization of metals in mineral veins to volcaic action, but this could be regarded as little else than a matter of assumption until some experiments actually supported this point of view. To M. Becquerel we are mainly indebted for the knowledge of the power of a single galvanic circle in producing powerful voltaic decompositions, whilst to our countryman, Dr. Faraday, we owe that most important piece of information, that poles or *attracting surfaces*, are by no means requisite to the crystallization of a metal by voltaic action, and that all that is necessary for the reduction of a metal from a salt or oxide is the mere passage of a voltaic current. That this current may be of the weakest intensity has been shown by Mr. Bird in an essay lately read before the Royal Society of London. The apparatus contrived by Mr. Bird was very simple, consisting of an external cylinder of glass, capable of holding about half a pint of fluid, filled with a solution of common salt (chloride of sodium); into the contents of this cylinder was plunged a second and smaller cylinder, furnished at its lower extremity with a plug of sulphate of lime: this second glass cylinder was filled with a solution of sulphate of copper; into the latter a plate of copper, furnished with a conducting wire, was immersed, whilst into the solution of salt a plate of zinc, also furnished with its conducting wire, was plunged. Under these circumstances, a current of electricity is developed, the plate of zinc becoming positive, and the plate of cooper negative, although the *intensity* of the current could be scarcely supposed sufficient to the production of chemical action. Mr. Bird has, however, shown, that when the connecting wires of the two plates of this elementary battery were immersed in a saline solution of a compound salt, the most important physical and chemical changes were produced; and that if, instead of immersing these wires in fluids, they are twisted together, so as to insure metallic connexion, it will be found that the electric current developed will produce most interesting and unexpected effects on the metallic solution present in the smaller cylinder; for, although it might be anticipated that the copper would be reduced, yet we should expect that this reduction would be most obvious at the surface of the negative electrode, which, however, Mr. Bird has shown not to be the case; for, on examining the plug of sulphate of lime (plaster of Paris), closing the smaller cylinder, and separating the solution of sulphate of copper from the brine, it was found that beautiful and hard crystals of metallic copper were deposited in it, not in a confused manner, but in veins precisely resembling those met with in mines, of which, however, it is scarcely necessary to observe they presented but a miniature resemblance. From this, it appeared, that the *mere passage of an electric current*, independent of the presence of poles, was sufficient to effect metallic reduction, supporting, in a satisfactory manner, the experiments of Dr, Faraday on this subject. The metallic crystals thus obtained were very hard and brilliant, resembling in a striking manner those produced in the vast theatre of nature—indeed, some specimens exhibited by Mr. Bird, obtained by the aid of his miniature apparatus, precisely, and, indeed, so closely resembled the most perfect forms of native and ruby copper ore, that they would probably defy the most expert mineralogist to discover their true origin. These effects were, moreover, by no means confined to salts of copper; for, when solutions of antimony, lead, tin, zinc, bismuth, silver, or other metals, were placed in the inner vessels, instead of a solution of copper, the metals were, in every case, reduced, partly on the plate of copper which served for the negative electrode, but chiefly imbedded in crystals in the mass of plaster of Paris closing the inner cylinder.

Other experiments, bearing upon this subject, were also detailed, which it is unnecessary to mention. They, with those already noticed, were considered interesting in explaining the cause of the deposition of metals in veins; for, as the magnetic theory of Arago, Ampère, and others, requires that free currents of electric matter should be perpetually circulating our earth in a direction at right angles to the magnetic meridian—so these currents, instead of merely causing the evolution of magnetic phenomena, are shown to be sufficient to produce most important chemical changes, causing, by their passage through masses of clay or earthy matter, the reduction and crystallization of the metals diffused through them in solution. To one circumstance, Mr. Bird particularly called the attention of the meeting—viz., the danger of considering the chemical changes produced in the bowels of the earth as in the first place depending upon metallic veins themselves; for, although it was evident that by the action of heat upon them thermo-electric currents may be, and no doubt are, developed, yet we must regard the first physical cause which induced the deposition and formation of these very veins; and this cause, it is evident, can be none other than, in the first instance, chemical action. Upon this point, Mr. Bird's experiments, in conjunction with those of Dr. Faraday and M. De la Rive, are certainly interesting, as throwing light upon that most obscure of subjects—the formation of metallic veins in the bowels of the earth.

A valuable part of this communication appeared to us to be, that in which Mr. Bird suggested that the silicification of wood is an electrical phenomenon. He has undertaken experiments to test this theory, and we are happy that so interesting a subject of inquiry should be in such competent hands.

In the Chemical Section, on Friday, some interesting communications were read on the formation of mineral substances. Mr. Robert Mallet read a paper, "On the Formation of Crystallized Metallic Copper, in the shafts of the Cronebane Copper Mine, county Wicklow, Ireland; and of Native Sulphate of Iron and Copper, in the same locality."

He alluded to the investigations, upon the subject of the precipitation of copper in a malleable state of Wach, Becquerel, and Clement and Bischoff, as

given by Professor Johnston in his report on Chemistry, drawn up at the request of the British Association, and showed that two separate causes had been assigned for its production. Metallic copper has been frequently obtained, as is well-known, by various methods in the laboratory, and in large masses in Daniell's Constant Batteries; but the present is the first occasion on which native copper has been found, actually detected, as it were, in the very act of formation in the mine shaft.

The Cronebane mine has been wrought for a very lengthened period, and has an additional interest as connected with the present subject, from the electro-magnetic condition of the next mine to it, the Connoree, which is part of the same vein, having been determined by Mr. Petherick, (*Philosoph. Mag. 3rd Series*, vol. 3.) He found it deflected the galvanometer needle 18° —that the ore was negative, and the ground positive. The lode is situated in clay slate, dipping to the S.W. The mine water is strongly cupreous, and deposits a slimy sediment of iron, and organic matter, probably "Glairine." In this slime, and adherent to the timbering of the mine, the crystals of pure malleable copper were found in considerable quantity. The mine water from whence these masses were formed, has a specific gravity of 1.032, at 58° Fahr. When evaporated to dryness, it leaves a horny residue, smelling of animal matter. It contains the mixed sulphates of copper and iron.

Amongst the many forces in operation to produce this metallic aggregation, the author suggests the possibility of galvanic action, between the lode and the timbering of the mine; having found the galvanometer much affected by a small series of plates of grey copper ore, and of fir timber, saturated with solution of sulphate of copper under the air-pump—the exciting fluid being the water of this mine. The slime appears to act the part of Becquerel's clay plugs, or Wach's diaphragms.

The author also presented a specimen of native sulphate of copper and iron, from the same mine; from the ochry slime at the bottom of a shaft of fifty fathoms deep, which had been full of water for above a century. It is found in small, brilliant, blueish green, rhomboidal crystals, and consists, according to the author's analysis, of:—

Sulphate of iron	34·2
Sulphate of copper	65·7
	99·9

This analysis does not present any exact atomic proportion between the two salts, taking the atom of sulphate of copper to weigh 15·62, as determined by Dr. Thompson, and containing five atoms of water; but it is remarkable, that if the sulphate of copper be supposed to be the green sulphate, which contains but one atom, and has an atomic weight of 11·12, the above analysis will correspond to three atoms of green sulphate of copper, and one atom of sulphate of iron. In favour of this view is the circumstance, that these crystals were formed at a considerable depth, and consequent high temperature; and that it is by similar means that the green sulphate of copper is artificially formed. On the other hand, while the common sulphate of copper is isormorphous with the sulphate of iron, that which has but one atom of water is not so; it crystallises in right prisms, while the common sulphate of copper assumes the form of the double oblique prism. It is possible, however, that the crystalline form of the green sulphate may be modified by the presence of the sulphate of iron.

The Mechanical Section was, on Monday, occupied for a considerable time by a discussion on the merits and performance of the Cornish steam-engines.

Mr. Henwood read an account of some experiments which he had made on the performance of some of the pumping-engines in Cornwall, and exhibited numerous tables and figures illustrative of the elements which affect them, and of the advantages obtained by working the steam expansively. The tables gave the dimensions of the various steam and exhausting vessels, the quantities of steam and water employed, the pressure of the steam both in the boilers and cylinders; and the diagrams (obtained by the use of the Indicator, an instrument which exhibits the pressure of steam at every period of the stroke, and describes on paper a figure by which this is accurately shown), proved that at the end of the working stroke the force of steam in the cylinder is insufficient to sustain the load of the engine, and that, therefore, a portion of the end of the stroke is made by virtue of the velocity obtained in the early part of it by the admission of steam of very high elasticity.

It appeared that in the engines which worked (in 1831-2) at Wheal Towan, Binner Downs, and East Crinnis mines, there were respectively 1,085, 1,006, and 870 tons weight lifted one foot high, for one farthing of expense.

A very protracted and animated discussion followed, in which many engineers from other parts of the kingdom expressed their doubts of the accuracy of the duty reported to be accomplished by the Cornish engines, and Mr. Guest, M.P., Dr. Lardner, Mr. Evans, Mr. Ham, Mr. Adams, Mr. Webster (the Secretary), and Dr. Robinson (the President) took a part. The substance of their objections (or rather doubts, for no one but Dr. Lardner more than offered possible cases of error), was, that the bushel of coal might be too large, the stroke of the engine short of what it was reckoned, the pumps "going in fork," loss of water by leakage of the clacks, &c.

In the course of the "cross-examination" to which Mr. Henwood submitted, it was stated that among the large recently-erected engines, those appeared to perform the best which worked from six to eight strokes per minute, and were loaded at from ten to twelve pounds on the inch; and that in experiments on the quantity of water delivered by the pumps, in which he had assisted Sir John Rennie, the deficiency was about one-tenth of the computed quantity.

He also stated his belief in the general accuracy of Captain Lean's report of the duty; but that in common with the engineers in Cornwall, he had no confidence in the results of 125 millions obtained by Mr. Galloway, at Wheal Towan, and by some Cornish gentlemen (not engineers) at Fowey Consols, because they varied from forty to fifty per cent. from the duty reported by Captain Lean, and because in all the trials which he had conducted or assisted at the performance of, varied but little from the monthly report, although the utmost precision of observation was employed.

Dr. Lardner attempted to invalidate these observations, but we are happy to add that his doubts and objections were fully answered, to the apparently high satisfaction of a crowded section, and to the manifest vexation of the learned gentleman.

On Friday, in the same section, at the request of Dr. Lardner (who thought to upset Mr. Henwood's testimony by a side-wind) Mr. John Taylor fully corroborated the accuracy of the duty reported, and showed that the money now paid for extracting the water from certain mines, is less than it was twenty years ago, in about the proportion that the duty of the engines has been improved in the interval, although the mines have been extended, and the quantity of water augmented by such extension.

Captain Lean confirmed the accuracy of these statements, and maintained the correctness of his engine reports.

We are gratified to find that a sum of money has been voted out of the funds of the Association for obtaining a summary of Captain Lean's reports from their commencement, and for instituting experiments on the performance of single and double engines out of Cornwall.

In the Mathematical and Physical Section, on Tuesday, Mr. Henwood made a communication "On the relative Temperature of Slate and Granite."

Mr. Henwood stated, that having had access to various mines in Cornwall, varying from twenty to 240 fathoms in depth, he had made numerous experiments on the temperatures of the several rocks, by means of the streams of water issuing from them; he would not delay the Section by detailing at length the experiments, which amounted to several hundred, but at once state the result, which was, that in every case he found the granite to be 13.°9 colder than the slate at the same depth; but the rate at which the temperature of the slate diminished in descending, was considerably slower than the rate at which the temperature of the granite diminished, the one being one degree in sixty-nine fathoms, the other one degree in sixty-five fathoms.

Professor Stevelly observed, that these results were interesting in two points of view; first, inasmuch as Professor Forbes, in his rambles in several parts of the Pyrenees, had found granite which was absolutely hot, and from which thermal springs were issuing, facts not a little puzzling to the geologists; while the researches of Mr. Henwood proved, that the high temperature of granite, when compared with other rocks, was not a fact of universal occurrence. The second point of view in which he thought Mr. Henwood's communication interesting was, that as the rate of cooling of the granite as you descended was greater than that of the slate, there must necessarily be some point within the earth at which their temperature would become equal, thus rendering still more probable a common source of high temperature to both within the earth.—Soon after Mr. Henwood had left the Section, a gentleman from Penzance, whose name has escaped us, came into the Section-room, and stated that he had hoped to arrive before the conclusion of Mr. Henwood's communication, as he had facts to detail from the mines in Cornwall which would lead to precisely opposite results to those deduced by Mr. Henwood; but as that gentleman had left the Section, he would not occupy time with any further remarks.

The following paper by Mr. Currie, giving the details of a *safety railway* system, was read to the Mechanical Section on Wednesday, and contains views relative to railways which possess some degree of novelty.

Railway communication is one of the most important improvements of the present age, and from which the public may expect much benefit and accommodation. The great obstacle to the extension of the present railways, arises from the large expenditure required in the construction, and also from the permanent injury occasioned to the land by deep cuttings, embankments, &c., which can scarcely be compensated, as well as opposing the most serious and dangerous obstruction to agricultural operation, and the local intercourse of the inhabitants generally, on each side lines of railways; but railway science being only in its infancy, it may be expected that such improvements will from time to time be made as may overcome these difficulties, to promote which is the principal object of this system.

In the course of investigating this subject, it has appeared to me, in which opinion I am joined by some eminent and experienced engineers, that it will be generally found, that railways will absorb the *light* traffic contiguous to the lines, while at the same time the *heavy* traffic will continue to move in its usual channels as at present, by water and waggons. If this principle be admitted, the immense capital required for the present railways being the principal obstacle to the more general adoption of this new and rapid mode of conveyance, may in some measure be removed by the *safety railway*, which is capable of being constructed, maintained, and worked, in proportion to the traffic expected on any proposed line, and I have accordingly classed the internal traffic of the country, viz.:—

Heavy traffic being such as is now conveyed by water and waggons. 1st. Agricultural produce of every description. 2d. Coals, minerals, and the raw materials, whether foreign or domestic. 3d. Manufactured goods and other property, capable of being made up into heavy bales and other large packages, for home or foreign consumption.

Light traffic is such as now conveyed by coaches, vans, &c. 1st. Passengers and other travelling baggage. 2d. Light and valuable goods, and other property requiring care, safety, and expedition in the conveyance. 3d. The royal mails, which may ultimately be expected to be conveyed by the railways.

In order to obviate the serious and well-founded objections to present railways, and as the rapidity of railway communication creates well-grounded alarm and apprehension for the safety of the inhabitants along the lines, I propose to place the *safety railway* out of the reach of *injury* to *persons* and *property*, by being constructed of *timber*, or other materials, and *raised* at least *ten feet above* the ground, and supported upon bearers of timber or other materials, when passing over gardens, ornamental grounds, arable land, and any low or level country, allowing *underneath* the railway *free* and uninterrupted access and communication, thereby leaving the country open, and removing every obstruction to agricultural operations, as well as the local intercourse of the inhabitants, who may pass by night or day without risk or danger.

The commencement of establishing the safety railway offers, perhaps, the only opportunity which may hereafter occur, of placing this most useful and important means of communication, upon a system of strict uniformity. It is, therefore, proposed to be constructed upon one uniform and regular system, in regard to the *gage* or breadth between the rails, so that all the carriages may run upon every line of railway throughout the kingdom. The safety railway being likely to obtain a straighter line than the present railways, as it is believed that landowners may not have any reasonable objection to allow the safety railway to pass over their lands, as it can be constructed, altered, or removed, without causing any *permanent injury* to the land, or occasioning very little damage to the materials of which it may be constructed. It may, therefore, be better with a view to the future improvements of railway communication, which ought not to be lost sight of, to proceed in the beginning upon the principle of *direct* lines, by drawing a straight line from one terminus to the other, and constructing the railway as near to that line as the nature of the country, and the state of railway science will admit of, as it may be expected that subsequent improvements will be directed to reduce the sinuosity, it being contemplated that inclined planes may ultimately be ascended by locomotives without stationary engines, thereby rendering cuttings, embankments, and tunnels unnecessary, and, consequently, occasion great saving of capital.

To render the safety railway more extensively useful and beneficial to the country, I propose to adopt certain *trunk*, *main*, or *royal* lines, from the metropolis, viz.—the Edinburgh—the Glasgow and Carlisle—the Newcastle—the Liverpool—the North Wales and Irish—the South Wales—the Bristol—the Exeter, to the Land's End, and also a cross line from Exeter by Bristol, Gloucester, Birmingham, to York, which cross all the other royal lines, thereby opening a more direct chain of rapid communication between the mining and manufacturing districts at both ends of the kingdom, without passing through London; and also a cross royal line from Lancaster to Cambridge. These royal lines are so arranged, that three-fourths of the principal inland towns and seaports are within from *one* to *twelve miles* of some one of these royal lines, consequently, it may occasion great saving of capital to railway companies, by directing their respective branch lines, which may seldom exceed ten or fifteen miles towards the royal lines, which the branches will thus contribute to support and maintain, rather than single towns or districts running separate lines of railways to London. In this respect very extensive improvements are in contemplation, by the adoption of lighter carriages, lighter power, and consequently less expensive railways, instead of the ponderous vehicles now used on the present railways.

It may be considered that the adoption of the safety railway may open a new medium of instantaneous communication, by means of the galvanic telegraph, to which it may be attached with ease and convenience, to any extent, at little expense, instead of being sunk under the turnpike road as proposed by Mr. Alexander, at very great expense. In 1805, I submitted to the late Lord Mulgrave, who was then Secretary of State for Foreign Affairs, a plan of ciphering for secret correspondence, which his lordship was pleased to say "is ingeniously constructed," and which I now find is peculiarly adapted for communications by the proposed galvanic telegraph, it being capable of such endless variations, that millions of persons might adopt it without the least risk of being deciphered by any person, except the parties using it. A person in Edinburgh, by delivering at the telegraph office a letter in cipher, with the proper address of any party in London, to whom, on being transmitted by, and transcribed from, the telegraph, it might be sent by post or special messenger, and the reply received in Edinburgh in less than one hour.

But little remark can be needed in closing the present report, which, although confined to those subjects only which are interesting to the miner and metallurgist, will display to our readers in a striking manner the wide sphere of utility which the Association embraces, and the powerful and combined talent which it is able to direct to subjects of practical or scientific research.

The place of meeting selected for next year, Newcastle-on-Tyne, is extremely well chosen, and much information will doubtless be brought forward on this occasion respecting this highly important coal mining district. The Duke of Northumberland has been elected President for the next year, and the Bishop of Durham Vice-President—an office which, owing to some unfortunate misunderstanding, was declined by the Earl of Durham.

The following sums were voted from the funds of the Association for conducting various inquiries—by

The Physical Section	£1555
,, Chemical.....	80
,, Geological	447
,, Natural History	75
,, Anatomical.....	200
,, Statistical	250
,, Mechanical.....	450
Total.....	£3057

Of the prosperous state of the finances of the Association, and of the liberality with which considerable sums are appropriated for the advancement of science, no better proof can be afforded than by the above statement, while we may observe, that for purposes of national importance, but requiring an expenditure disproportioned to its funds, it has been successful in obtaining the powerful and effectual aid of Government.

A Fact for Naturalists.—In the neighbourhood of Bierley there is a tree which a few years ago was split with lightning. An iron chain which was fastened round it in order to restore it to its pristine form is now covered with bark, and the tree is in good condition.—*Blackburn Standard.*

Coals.—In the year 1780, the demand for coals amounted to 2½ millions of tons per year; in the year 1833 to 18 millions. The increase of population (according to Bowring) has been during that period 90 per cent; the increase in the demand for coals 730 per cent, and it is calculated that there is no fear of a falling off in the supply for 2000 years.—*Raumer's England.*

ORIGINAL CORRESPONDENCE.

HOT-BLAST.

TO THE EDITOR OF THE MINING JOURNAL.

Sir,—In common with many others, I much regret Dr. Thompson's analysis of iron does not extend beyond that manufactured in Scotland. His experiments, as the correspondent of the *Merthyr Guardian* (quoted by you) justly remarks, being merely a description of the value of the hot and cold-blast iron manufactured in that country, leaving the question of the comparative value of that made in other districts still open. I must also beg to state, that, independent of this, I do not consider the experiments to have been conducted on that fair and equitable principle which ought to have been followed, to have given them that weight, as coming from under the hands of so able a chemist, they otherwise would have had. To have shown a fair comparative result, there ought to have been an equal number of analyses of specimens obtained from each work, and made under the hot and cold blast systems. Instead of this course having been pursued, the average analysis of the cold-blast iron has been taken from the produce of four manufactories, of which the specimen from one of them, pyrites, shows an excessive quantity of the metals of silex and alumine, as compared with the others; and another from Clyde, exhibits an unaccountable quantity of aluminum. This latter is a circumstance so anomalous, that it most probably must have proceeded from some accidental cause. With the very pure and rich ironstone made use of in that country, as shown by the analysis of the Blackband ore, one would really wonder where the plague all this aluminum comes from. Suppose an atom of aluminum to be ten, and that it unites to an atom of oxygen eight (of which, I believe, the learned Professor states alumine to be constituted), the aluminum found in this specimen, say 4·602, will be represented by 8·283 of alumine. We will assume two tons of blackband to be required to produce a ton of iron. The quantity of alumine, as shown by the Doctor's analysis, would be equal to about 28 lbs. introduced into the furnace with the above quantity of stone; assuming the whole of this quantity to be revived, and to combine with the iron, a circumstance by no means very probable, it will amount to no more than 1·25 per cent., a quantity much at variance with the before-mentioned 8·283. Whether the black band is smelted by itself, or only a proportion of it, with stone of a less productive quality, I have no data to calculate upon; the probability, however, is that the latter course is adopted, in which case a larger proportion of alumine than I have shown above, may be introduced into the furnace, but I suspect not sufficient to make this a fair specimen of the iron produced. In South Wales the quantity of alumine found in the ironstone is about six per cent., of which about one-twentieth is revived; and, judging from analogy, I think I may say, I am justified in the suspicion I have above stated.

It is far from my intention to impugn the accuracy of the analysis; was I to do so, it might very justly be considered a piece of presumption, as being the work of so celebrated a man; but I must be permitted to state, that it is my opinion, the result recorded proceeded from some accidental and anomalous circumstance, which very probably might have been made apparent, had the result of other analyses been shown. As I have before mentioned, I do not think the experiments have been satisfactorily conducted, the average of the hot-blast analysis having been taken from iron produced at Carron and Clyde only, leaving out Muir Kirk and Pyrites, the latter of which, as before observed, contained an excessive quantity of metallic earths. As an analysis of the hot-blast iron produced at this work has not been given, that of the cold-blast ought to be rejected in making up the average, as also should the specimens showing so large an excess of alumine; this being done, the metals of silex and alumine in the cold-blast iron will be to those in the hot-blast iron as ·996 is to 1·507—a result more in accordance with probability than that shown; for, as I observed in a former letter, if the furnace, by the use of hot-blast, is placed in a more favourable situation for the reduction of the iron, it must also stand in the same situation, as regards the reduction of the earths, which require the action of precisely the same agents for their revivification.

The result of the trials of the strength of both kinds of iron, as far as is shown in your paper (and I have seen no other report), is as little satisfactory as the analysis, inasmuch as the experiments are upon too limited a scale to show any thing like a general result. Of Staffordshire iron there has been but one experiment made, the result of which was against the hot-blast iron. Of South Wales iron there is no experiment recorded, whether any were made or not does not appear. An application was made to a gentleman of this neighbourhood for specimens of his iron, which he declined to forward to Manchester, where they were required, considering it probable, in the transit of small lots, they might be mixed or changed; but he expressed his perfect readiness to allow samples to be selected from his stock at his works, where they should be tested in any way which might have been considered necessary to arrive at correct results; this, however, I presume, was not approved of. Whenever experiments are made on South Welsh iron, and I believe I may add Staffordshire also, I may with confidence state my opinion to be, that the results will closely approximate to those which I have made and communicated to you.

If I shall not be trespassing too far on the limits of your paper, I would just observe, that I presume the late communication of your correspondent, M. de Boussois, is intended to elucidate the new theory of the reduction of metals, which he some time ago promised. His ideas of the process of smelting, chemically considered, certainly appear to be correct and rational, but in what they are new, I am rather at a loss to make out. It may be inferred from his remarks, that it was supposed that the decomposition of the oxide of iron, was the entire results of their actual contact with the charcoal or coke, in its crude state, in the furnace. That this is partially the case, I believe there are few will doubt, it being very certain, that where oxide of iron and solid carbon touch, the result will be the decomposition of the ore, just so far as the particles are in actual contact with each other; but that any one in the present day, theoretically and practically acquainted with the process, should for a moment suppose that actual contact of the gross materials was a necessary requisite to the reduction of the oxide, would imply a thorough ignorance of the process. Any one who could advance such an opinion, must infer an amalgamation of the materials totally inconsistent with the working of a furnace.

This gentleman has thought proper to apply the term "futile" to my suggestion of the cause of the discrepancy in the strength of the iron manufactured at Butterly and Low Moor, as arising from local causes. He must, however, allow me to tell him, that his remarks are much more futile, and exhibit but a small portion of practical knowledge, it being a matter notorious to every one conversant with the manufacturing of iron, that there are physical differences both in ironstone and coal, which materially affect the quality of the iron produced, and which no modification of the process can remedy. I am, Sir, your most obedient servant,

Abersychan Iron Works, Pontypool, Oct. 10. W. Wood.

Bills of Exchange.—By the 1st Victoria, c. 80, it is enacted—"That from and after the passing of this Act, and till the first of January, one thousand eight hundred and forty, no bill of exchange or promissory note made payable at or within twelve months after the date thereof, or not having more than twelve months to run, shall by reason of any interest taken thereon or secured thereby, or any agreement to pay or receive or allow interest in discounting, negociating or transferring the same, be void, nor shall the liability of any party to any bill of exchange or promissory note be affected, by reason of any statute or law in force for the prevention of usury; nor shall any person or persons or body corporate drawing, accepting, indorsing, or signing any such bill or note, or lending or advancing any money, or taking more than the present rate of legal interest in Great Britain and Ireland respectively for the loan of money on any such bill or note, be subject to any penalties under any statute or law relating to usury, or any other penalty or forfeiture; any thing in any law or statute relating to usury, or any law whatsoever in force in any part of the United Kingdom, to the contrary notwithstanding."

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The Mining Journal
AND COMMERCIAL GAZETTE.

SUPPLEMENT---XXVI.

REVIEWS.

A practical and scientific Treatise on Calcareous Mortars and Cements, artificial and natural, containing directions for ascertaining the qualities of the different ingredients, for preparing them for use, and for combining them together in the most advantageous manner, with a theoretical investigation of their properties and modes of action. By L. J. VICAT, Engineer-in-chief of Bridges and Roads, &c. &c. Translated by Capt. J. T. SMITH, Madras Engineers, F.R.S., &c. &c. Weale, London. 1837.

There is probably no error more common or more mischievous than that which disunites theory and practice, which considers as distinct, or even as opposed to each other, two elements of knowledge which, although derived from different sources, tend to one common point, and produce, when combined, the most valuable results. Practice gives the method—theory gives the reason—the man who possesses the former may do much, but he who possesses both will accomplish more, and will generally find both a shorter and surer road to effect the object which he has in view.

There are, doubtless, many to whom an octavo volume on "mortars and cements" will appear little better than a superfluity, who will consider that the knowledge on the subject possessed by every builder or mason is amply sufficient, and that an affair so apparently simple, neither requires nor admits of the application of scientific principles and investigations; such, however, we would refer to the volume before us, and we believe that a perusal of a few pages only would be quite sufficient to show the fallacy of the views which they had so hastily entertained, and to demonstrate that this department of building and engineering is well deserving of much greater attention than that which is generally bestowed on it.

The formation of mortars and cements is a process of extreme antiquity, taking its rise indeed almost from the period when mankind first began to employ stone or brick for the purpose of building. It appears probable, however, that some of the earliest cements were not calcareous—the idea of imitating Nature in the process whereby she forms rocky and stony matter, being perhaps too refined for the early ages when the art of building first began to be practised, and thus, in some cases, natural cements alone were used. In that portion of Asia in which the earliest settlements of mankind were located, bitumen is known to exist in considerable abundance, and it is stated by historians that this mineral, in a hot and fluid state, was used for cementing the walls of Babylon, one of the largest and most celebrated cities of early antiquity; thus rendering it probable that this natural cement was extensively used at the remote period of history to which we have referred. Confined, however, as it is, to peculiar localities, the use of this substance could never have extended very far beyond them, and hence must early have arisen the necessity for obtaining a substitute more generally attainable.

The formation of calcareous cements similar to those of the present time was well known to the ancient Egyptians, who, from the colossal size of their structures, were doubtless induced to pay considerable attention to the manufacture of the material which was used to bind these enormous masses together. In the work before us, M. Vicat states the remarkable fact, that "the mortar which binds the blocks of the Pyramids, and more particularly those of Cheops, is exactly similar to our mortars in Europe." Of the durability and excellence of the cements used by the Romans, we have abundant evidence in the remains of many of their works still existing in this country, and the term "Roman cement" has thus been given, though not, perhaps, with very strict propriety, to one of our most valuable modern compounds of this nature. It is well known that till within the last few years, portions of the wall built by the Romans round the ancient city of London were, after the lapse of seventeen or eighteen centuries, still entire, and in our younger days we have often amused ourselves by putting to the test the excessive hardness and unyielding texture of the cement which binds the walls of Silchester, in Hampshire, the interesting ruins of the Roman station called *Vindonum*.

The investigation of the nature and properties of different cements, the ingredients best adapted for their manufacture, or the modes in which they should be compounded, are subjects which have hitherto received but little attention from scientific men in this country, and notwithstanding the vast sums annually expended in buildings and public works, and the consequent importance of employing the best and most durable cements in their construction, scarcely any thing has yet been done towards reducing our knowledge of the subject to a system, and proceeding by the certain rules of science, instead of trusting to the precarious results of chance, or following implicitly the often erroneous precedent of established custom. The work of Dr. Higgins is, we believe, the only one in our language which treats on the nature and manufacture of cements, and this has long since been of but little value, having been written at a time when both the art of engineering and the science of chemistry, the latter especially, were very different from what they now are.

Under these circumstances, a work at once practical and theoretical, like the one before us, cannot fail to be welcomed by a large class which must have hitherto felt the want of such a desideratum The merits of M. Vicat's work are well established, and Captain Smith has not only ably fulfilled the task of a translator, but has given additional value to his author by a considerable number of notes and observations, the result of his own experience on the subject, most of these being of such a nature as to combine the results of experiments in this country with those so well described by the French engineer abroad.

The following extract from the author's preface will best show the state of the art on which he treats about five and twenty years ago, when, to remedy the evils complained of, an extensive series of experiments were undertaken by the French Government engineers.

"The art of composing calcareous cements was confined, till within the last few years, to the knowledge of a small number of facts, and to the observance of certain rules long since admitted into use without examination, on the authority of Vitruvius and the architects who followed him. But the rules were almost always found to be at fault, and the facts, for want of correlativeness, were but of little aid. Could we, for instance, manufacture good mortar in France, by mixing three parts in bulk of dry pit sand, or two of river sand, with one part of slaked lime derived from a white marble of great hardness? Such, however, are the proportions of admixture, and the characteristics of good limestone pointed out by Vitruvius. It was of little importance besides to those, to whom it was impossible to procure it, that the pouzzolana of Italy and the Dutch tarras were possessed of extraordinary binding qualities; that lime eminently adapted for hydraulic works was to be found at Metz, Viviers, Nismes, &c., in France, at Lœa, in Upland, at Aberthaw, in England, and elsewhere. With all this information, and even adding to it the discoveries of the Swedish Baggé and Count Chaptal, regarding the transformation of some schists, and certain ochreous clays into pouzzolanas by calcination, it was not the less necessary to work by guess in most instances, or to trust to obscure analogies for the success of the most important works. One engineer vaunted the efficacy of the powder of *well-burnt* tile, another looked upon smithy slag and iron-dross as the finest ingredients. These again, on the other hand, asserted that such substances are destitute of energy. Lastly, this difference of opinion extended even to the manipulation of the compounds. Was the lime to be slaked with much water, or to be allowed to fall to powder after having immersed it for a few seconds? Should it be applied hot or cold? &c. Every plan had its partisans; and what doubtless appears paradoxical was, that each method too was supported by experiments and testimony, of which it was hardly possible to dispute the authenticity.

"We shall leave it to the reader to appreciate a state of things like this, and to decide whether such a chaos of opinions and opposing facts could or could not make up a science—a doctrine of calcareous cements. Perhaps it may be replied, that at the epoch of which we speak, builders had learnt to erect bridges, locks, &c., without either tarras or pouzzolana, and in countries where the lime possessed no extraordinary quality. Without denying this truth, we must remark, that most of these works have not endured, nor can continue to endure, but by frequent and expensive repairs. That on many canals it has been necessary to reconstruct a great many locks, whose side walls were in a few years found to be quite stripped of mortar. That a multitude of dikes, sluices, weirs ("barrages"), and aqueducts, of recent construction, already exhibit all the characteristics of age, without the possibility of attributing these unexpected dilapidations to any other cause than the bad quality of the mortars or cements made use of."

The experimental researches to which we have alluded were commenced in 1812, and, after being continued about six years, the results were first published in 1818, forming the origin of the work before us, which, although not previously translated into English, has for many years possessed a high reputation on the continent.

The following extract from the translator's preface will best explain the views with which the work before us was undertaken, while it proves the value which he attached to M. Vicat's work, as a practical man only, and without any immediate intention of executing this task with a view to publication.

"The merits of M. Vicat's valuable researches into the composition of mortars and cements are already too well known, to render it necessary for me to apologise for an endeavour to extend their usefulness, by submitting them to the public in a more accessible form. But as the motives which induced me to undertake this work, and have encouraged me to persevere in its fulfilment, may require explanation, I ought not to refrain from making them known, nor from claiming that indulgence for the result of my labours, which the peculiar circumstances under which they have been accomplished render necessary.

"Having been occupied for many years in the construction and repairs of numerous public buildings, the charge of which devolved upon me in the performance of staff duties, I was long embarrassed, in the endeavour to give durability to works executed under my superintendence, by many difficulties arising from the defective quality of the cements employed, the dampness of the situation, and other causes at the time unknown.

"Anxious to remedy these evils, I engaged in a series of experiments, in which numerous modifications of the processes previously employed, and every suggestion which could be gleaned from the scattered hints contained in the writings of the various English authors who have incidentally touched on the subject, were put to trial, both with reference to the durability of the compounds, as well as their economy on the large scale. But although these endeavours were followed by many promising results, it was not until I became possessed of M. Vicat's work, that the theory of the composition of mortars and cements was developed in a sufficiently satisfactory and comprehensive manner, to enable me to take a full view of the varied resources found within the limits of almost every locality, for the fulfilment of the objects of which I was in search. But, systematic and plain as M. Vicat's instructions and experiments are when well understood; yet it was not without much labour, in repeating many of the experiments, and the perusal of other French authors on the same subject, that I was enabled to overcome the difficulties occasioned by my imperfect acquaintance with the exact meaning of the numerous technical terms employed in it, and fully to appreciate the originality and appropriateness of the experiments, and the depth and philosophical accuracy of the reasoning founded on them. Having surmounted these obstacles, and felt the great value of the copious information placed at my disposal, I could not look back upon the pains which it had cost me to effect my object without being led to consider, that others similarly situated with myself might have the same impediments to contend with; and that I might assist future inquirers, by placing the labours of M. Vicat within the reach of those who might not possess sufficient leisure to give that attention to his work which I had found to be indispensable.

"Of the desirableness of such a work, indeed, it needed but little consideration to satisfy me; for though intimately connected as such researches are with the success and durability of our most important constructions, and with the security and domestic comforts of every class of civilised society; it is remarkable, that since the publication of Dr. Higgins, now rendered obsolete by the rapid strides which the art has taken since his time, no English work on this subject has yet appeared. Nor have the investigations connected with it, hitherto, attracted the attention of any of the distinguished philosophers, to whom science and the arts are in other respects so largely indebted.

"At a time, therefore, when the rapidly extending demands of a quickly progressive civilisation, daily give birth to new and stupendous undertakings, there could be no doubt as to the benefits which must result from bringing before the public, the labours of those who have devoted themselves to the study of this very important and hitherto neglected branch of architecture, and of placing within their reach the many valuable facts brought to light by them."

The first chapter is devoted to the consideration of "calcareous minerals, and the various kinds of lime they furnish," on which the author very justly remarks—

"It is useful to be acquainted with this nomenclature; but that which it is of the most importance for the builder to be aware of is, that each variety of limestone furnishes a peculiar kind of lime, distinct in colour, weight, in its avidity for water, and, above all, by the hardness it acquires on being mixed intimately after slaking with the earthy substances known under the names of sand, puzzuolana, &c."

We extract the following observations on the process of burning limestone in the large way, a subject deserving of more attention than is generally given to it:—

"Limestone becomes lime on being deprived of its carbonic acid, and of the water it contained, whether hygrometrically or in combination. The agent employed to effect this is heat.

"With the same heat, the calcination is effected with more ease and rapidity in proportion as the stone is of a less compact texture, to the smallness in bulk of the fragments into which it is reduced, and to its being impregnated with a certain degree of humidity.

"The contact of the air is not indispensable, but it exercises a useful influence, especially in regard to argillaceous limestone. Moreover, no limestone can be converted into lime in a vessel so close as to render the escape of the carbonic acid impossible.

"Limestone which is pure, or nearly so, supports a white heat without inconvenience; the compound limestone, on the other hand, allowed in the proportions necessary to form hydraulic or eminently hydraulic lime, fuses easily. Its calcination demands certain precautions: the heat ought never to be pushed beyond the common red heat, the intensity being made up for by its duration.

"The compound limestone, when too much burnt, is heavy, compact, dark-coloured, covered with a kind of enamel, especially about the angular parts; it slakes with great difficulty, and gives a lime carbonized and without energy; sometimes it will not slake at all, but becomes reduced, after some days' exposure to the air, to a harsh powder altogether inert.

"The pure and compound limestones when insufficiently burnt, either refuse to slake, or slake only partially, leaving a solid kernel, a kind of subcarbonate with excess of base, which possesses properties of which I shall have to speak elsewhere.

The calcining of calcareous minerals constitutes the art of the lime-burner. According to situation, either firewood, faggots, brushwood, turf, or coal is used."

The third chapter is devoted to the consideration of hydraulic limes, and as this subject does not occupy a very great space, we shall extract it entire:—

"Six years have elapsed since the publication of my first researches into this subject; and already the artificial limes have been applied to a number of important works. The canals of Saint Martin and Saint Maur made almost exclusive use of them. Nearly a thousand cubic metres have been employed within five years at the harbour of Toulon. These limes have served for the fabrication of the beton for the foundations of several bridges; and their consumption is increasing daily in Paris and its environs.

"We have no longer, therefore, to attend to laboratory experiments, but indeed to a new art, very nearly arrived at perfection.

"The artificial hydraulic limes are prepared by two methods: the most perfect, but also the most expensive, consists in mixing with rich lime, slaked in any way, a certain proportion of clay, and calcining the mixture; this is termed artificial lime *twice kilned*.

"By the second process, we substitute for the lime any very soft calcareous substance (such, for example, as chalk, or the tufas), which it is easy to bruise and reduce to a paste with water. From this a great saving is derived, but at the same time an artificial lime, perhaps of not quite so excellent a quality as by the first process, in consequence of the rather less perfect amalgamation of the mixture. In fact, it is impossible, by mere mechanical agency, to reduce calcareous substances to the same degree of fineness as slaked lime. Nevertheless, this second process is the more generally followed, and the results to which it leads become more and more satisfactory.

"We see that by being able to regulate the proportions, we can also give to the factitious lime whatever degree of energy we please, and cause it at pleasure to equal or surpass the natural hydraulic limes.

"We usually take twenty parts of dry clay to eighty parts of very rich lime, or to one hundred and forty of carbonate of lime. But if the lime or its carbonate should already be at all mixed (with clay, Tr.) in the natural state, then fifteen parts of clay will be sufficient. Moreover, it is proper to determine the proportions for every locality. In fact, all clays do not resemble one another to such an extent as to admit of their being considered as identical: the finest and softest are the best.

"There is at Meudon, near Paris, a manufactory of artificial lime set on foot by Messrs. Brian and Saint Leger. The materials made use of are, the chalk of the country and the clay of Vaugirard, which is previously broken up into lumps of the size of one's fist. A millstone set up edgeways, and a strong wheel, with spokes and felloes, firmly attached to a set of harrows and rakes, are set in movement by a two-horse gin, in a circular basin of about two metres (six feet and a half English) radius. In the middle of the basin is a pillar of masonry, on which turns the vertical arbor to which the whole system is fixed: into this basin, to which water is conveyed by means of a cock, they throw successively four measures of chalk and one measure of clay. After an hour and a half working, they obtain about 1.50 metres cube (nearly fifty-three cubic feet English) of a thin pulp, which they draw off by means of a conduit, pierced horizontally on a level with the bottom of the basin.

"The fluid descends by its own weight; first into one excavation, then into a second, then a third, and so on to a fourth or fifth. These excavations communicate with one another at top. When the first is full, the fresh liquid, as it arrives, as well as the supernatant fluid, flow over into the second excavation; from the second into the third, and so on to the last, the clear water from which drains off into a cesspool. Other excavations, cut in steps like the preceding, serve to receive the fresh products of the work, whilst the material in the first series acquires the consistency necessary for moulding. The smaller the depth of the pans in relation to their superfices, the sooner is the above-mentioned consistency obtained.

"The mass is now subdivided into solids of a regular form, by means of a mould. This operation is executed with rapidity. A moulder, working by the piece, makes on an average five thousand prisms a day, which will measure about six cubic metres (211.8 cubic feet English). These prisms are arranged on drying shelves, where in a short time they acquire the degree of desiccation and hardness proper for calcination. This may be effected by any one of the methods described in the preceding chapter. At Paris they employ a mixture of coke and coal, and the common mode of burning by slow heat, rendered necessary by that kind of combustible.

"The artificial hydraulic limes are intended to supply the place of the natural ones in those countries where the argillaceous limestone is entirely wanting. They are sold at Paris, at from seventy to seventy-four francs per cubic metre. In the country they may be had for forty francs, on an average, when twice kilned, and will not come to more than thirty francs, when they result from a mere mixture of chalk and clay."

Treating of hydrates of lime, we have the following observation on the process of slaking:—

"Numerous preliminary trials have shown, that the quantity of water employed in slaking the lime exerts a powerful influence on the hardness of the hydrate which results. And this is easily understood. Too little water fails to bind the mass; an excess swells out the stuff, which remains light, porous, and friable, if it does not shrink proportionably in drying. Plaster mixed thin, or stiff, exhibits a remarkable instance of this fact."

We extract the following observations on clays, considered as ingredients of cements:—

"Clays are earthy substances variously coloured, fine, soft to the touch, which diffuse in water with facility, forming with it a paste, which, when kneaded to a certain consistency, possesses unctuosity and tenacity, and may be drawn out and kneaded in every direction without separating. The clayey paste, when dried, retains its solidity, hardens in the fire, &c.

"Clays are essentially composed of silica and alumina: these two substances are adulterated by the presence of the oxide of iron, the carbonates of lime and magnesia, sulphuret of iron, and of vegetable combustible matter partly decomposed.

"The clays are separated into four classes, viz.: the refractory, which resist, without melting, the heat of the porcelain furnaces (140 deg. Wedgwood); the fusible clays; the effervescing, or clayey marls; and, lastly, the ochrey clays, coloured red or pure yellow by the oxide of iron.

"The position of clays is very varied: we find them as veins in primitive formations; in hillocks, on the confines of the primitive chains; in horizontal beds, or layers, in the secondary formations; in threads, thin veins, or infiltrations, in chinks and hollows of calcareous masses; lastly, in volcanic regions. There, their formation is attributed to the decomposition of the compact lavas, and perhaps also, with some probability, to miry eruptions."

The following are M. Vicat's observations on natural and artificial pouzzolanas:—

"Pouzzolana, properly so called, is a volcanic matter, pulverulent, of a violet red colour, first dug out of the earth by the Romans near the town of Pouzzol, not far from Vesuvius.

"The environs of Rome furnish it equally. The naturalist, Faujas de St. Fond, has found it in France, on the extinct volcanoes of Vivarais. There are few regions exposed to igneous agency which are destitute of it. But it presents itself under very different physical appearances; sometimes pulverulent, sometimes in coarse grains, often in slag, pumice, tufa, &c. Its colour, which is generally brown, passes to yellow, grey, and black.

"We shall, in the rest of this work, comprehend under the name of pouzzolanas, the pseudo-volcanic products arising from the ignition of coal-pits, such as the tripolis, calcined sandstones, clays, &c.

"Of these substances, some appear to have been exposed to a very high temperature; others seem to have been only slightly scorched. Many appear to have been re-acted on, and modified anew by the heat, or altered by the effect of a very slow spontaneous decomposition. These changes have determined in the constituent principles a union more or less close, and consequently more or less difficult to overcome by chemical agents.

"The pouzzolanas are essentially composed of silica and alumina, united with a small quantity of lime, potash, soda, and magnesia. Iron is associated with them mechanically, in the magnetic state.

"*Artificial Pouzzolanas.*—Under this denomination we shall include the clays, arenes, psammites, and schists, properly calcined; smithy slag, the refuse of the combustion of turf and coal, and pounded earthenware; and, lastly, tile and pot shards."

We have observed that Captain Smith has added many valuable notes of his own to the work—as an example, we may quote the following, which is appended to the passage above extracted:—

"Mr. Smeaton tried powdered forge-scales, such as fall from iron at a smith's anvil, with excellent effect. Also the siftings of the ironstone after calcination at the iron furnaces, called "minion," which were ground in a mill previous to mixture with lime. He considered the forge-scales, when well powdered, and sifted clean from dirt and glassy slag, to be equivalent to as much pouzzolana, or tarras; *rust* of iron, or iron ore burnt, powdered, and sifted, to be equivalent to *minion*; and each of these last to about half the quantity of pouzzolana, or tarras. In the construction of the new Docks at Sunderland, which I visited during their progress, in May, 1335, I found that the cement used there, was a mixture of two parts of lime (which was obtained from a blue species of limestone, probably lias) and one part of the ground slag from the iron founderies in the neighbourhood. I examined some of the lumps of slag lying about; they seemed to contain much iron, either in the metallic state, or as the protoxide Before being applied to use, they are ground on a cast-metal bed to a very fine powder; and I was informed that the ashlar work was mostly all united with a cement of this powdered slag and water, without any admixture of lime. This was kept dry for a couple of days, in which time it set; and it afterwards indurated slowly, becoming of a stony hardness."

On the influence of time upon cements, M. Vicat makes the following remarks:—

"Some persons are in the habit of concluding upon the future goodness of a cement by the rapidity of its "set;" numerous facts prove that this indication is not always constant. The second process of extinction, for instance, hastens the set of all betons of powerfully hydraulic lime, but does not lead to as great a degree of hardness as the ordinary process. Besides, there are ingredients whose binding qualities are only developed in a slowly progressive manner, and which, nevertheless, attain a very high degree of solidification. The time of first setting cannot be taken as an exact prognostic of the future hardness, except when we compare together cements or mortars of the same kind; thus, for example, when a mixture of 200 parts of pouzzolana and 100 of rich lime takes six days to set, while a mixture of the same consistency of 200 parts of the same pouzzolana with 270 parts of the same lime take nineteen days, it is certain that the first will become more hard than the second. And this will also be true, if, while the proportions continue invariable, the cements differ merely by the quantity of water introduced into them, and if, by reason of this difference, the more stiff one sets sooner than the other."

In another part of the work, M. Vicat observes—

"'Mortar a hundred years old is still in its infancy.' This saying of the masons is the result of the daily observations which they have the opportunity of making in demolitions. It is seldom, in fact, that we meet with good mortars of rich lime, except in the foundations or masonry of buildings of four or five hundred years old. What is it that determines such a tardy solidification? It is a thing which it appears difficult to account for; however, there is one thing which it is not at all difficult to apprehend, and that is, that a mortar which does not harden for four or five hundred years, is to us much the same as if it never hardened at all.

"As regards hydraulic, or eminently hydraulic mortars, numerous experiments which we have collected prove, that when exposed to the air in small bulk, they in a very short time (eighteen to twenty months) attain, if not the ultimate degree of hardness of which they are susceptible, yet at least a condition differing so little from it, that we are enabled to predict with certainty what they will ultimately become.

"Thus the influence of ages may modify, but not overturn, the relations in respect to durability established by our observations."

The following hints are worthy of attention:—

"Mortar in every season ought to be prepared as much as possible under cover, whether it be to avoid the rapid dessication which takes place in summer, or to obviate the still more serious inconvenience in the rainy season. In the latter case, we ought to deviate a little from the principles which we have laid down in the preceding remarks, and choose the hydraulic lime slaked by immersion, in preference to that produced by the ordinary mode; and this in order to have it in our power at pleasure to absorb the water contained in the wet sand; without this plan, it is impossible to obtain a stiff mortar.

"In summer, on the contrary, the lime in paste is not always sufficient to moisten the sand, which is sometimes hot. It then becomes indispensable to add water, but gradually, and with the greatest caution. One could hardly believe, without witnessing it, how very small a quantity is sufficient to drown the mixture."

The author proceeds to treat of the manipulation of mortars, of natural cements, of ancient mortars, and of the various theories which have been proposed on the subject of cements, concluding the volume by an appendix, consisting of a series of notes and valuable tables. We have already expressed our favourable opinion of the work, and the numerous extracts now given will have fully justified it, we shall, therefore, merely observe, in conclusion, that the present volume deserves to find a place in the library of every architect, builder, and engineer, to each of whom it will prove an exceedingly valuable companion.

Conversations on Mineralogy; with Plates, engraved by Mr. and Miss LOWRY, from original drawings. In two volumes. Third edition, enlarged. Longman and Co., London. 1837.

There are few respects in which the literature of the present period is more favourably distinguished from those which have preceded it, than in the number and excellence of the elementary works which have appeared, embracing all the various branches of art and science. There is now scarcely a subject, however abstruse and complicated, the elements of which have not been rendered both simple and pleasing, and all preliminary difficulties so far cleared away, that with a moderate degree of application only, the learner is enabled to acquire all that for general purposes is required to be known.

This office has been ably performed for the science of mineralogy in the two pleasing little volumes before us, which, in a series of conversations between a teacher and her pupils, furnish a very useful abstract of all the most important facts with which we become acquainted in the examination and arrangement of mineral substances. The conversational style which has been adopted enables the information to be conveyed in a simple and pleasing manner, and gives an opportunity of introducing many remarks which would not be altogether consistent with a more precise and systematic treatise, although they considerably relieve the occasional dryness of the subject.

The following extract from the preface will best explain the nature of the work, and the principles which the author has kept in view:—

"It has not been my intention, in the following pages, to enter into very minute details, or to support any particular system, but to give my readers clear ideas of the principles of Mineralogy and of Crystallography. With respect to the latter subject, though my observations are founded on the highly ingenious and scientific theory of Haüy, a part of them, and the figures by which they are illustrated, are new; and I feel assured that they will be found useful in explaining facts which it is often difficult for beginners to comprehend.

"In my descriptions of minerals, I am aware that there is little novelty, nor can much be expected from the limited plan of this work; since many of the rare minerals are necessarily passed over almost in silence. I have constantly given a much more detailed account of the substances which are abundant or useful, than of those which are scarce, and consequently of limited application; and I have seldom neglected to mention the purposes to which they are applied in the different arts or manufactures, or any other interesting circumstances connected with them.

"My classification of minerals differs in some respects from all that I have seen; but as it is not, I believe, likely to perplex the learner more than most other arrangements, I trust it will not be severely criticised. It is probably as defective as those which I have examined, and rejected because I was dissatisfied with them.

"To construct an unexceptionable arrangement of minerals, founded partly on their chemical composition and partly on their external characters, was long considered a desideratum: it is now acknowledged to be impossible. The mode of classification founded on external characters only, adopted by Professor Mohs, is a system of description, which gives the student no information concerning the most important relations and differences of minerals; namely, those dependent on their composition. On the other hand, the chemical and truly scientific arrangements of Berzelius and Beudant must appear perplexing to persons who have not some previous knowledge of chemistry; and especially of the laws of combination of atoms in definite proportions.

"Under these circumstances, I have preferred adopting a system of the mixed kind, similar to some others, but availing myself of many recent discoveries in the composition of various substances, their localities, &c."

We have already observed, that the work consists of a series of conversations between a teacher and her pupils—Mrs. L. (Mrs. Lowry, we presume) receives a visit from two young ladies, who have just returned from the British Museum, where they have been much struck with the beauty and variety of the mineral specimens. From the ordinary remarks suggested on such an occasion, the first conversation commences, and we shall give a short extract to show the simple and familiar manner in which some of the preliminary principles of science are explained.

"MRS. L.

"I can tell you many things relating to minerals far more strange than that. Did you not see some diamonds?

"MARY.

"Yes; beautiful little things, very bright, and all of different forms:

"MRS. L.

"Well, you will hardly credit me when I tell you that they are nothing more than charcoal. "FRANCES.

"How can that be? diamonds are very scarce and valuable, and charcoal is only burnt wood, which is very cheap.

"MRS. L.

"True; but although we cannot make diamonds by burning wood, or in any other way, we are certain that they *are* charcoal, though not in the state in which we generally see it. "FRANCES.

"I do not exactly understand you.

"MRS. L.

"I will endeavour to explain myself better. Bread is made of flour, yeast, salt, and water: yet we are not able to convert a loaf into these ingredients. So, though chemical experiments have proved that both charcoal and diamonds are essentially composed of a substance called *carbon*, chemistry has not discovered any operation by which charcoal may be rendered pure and crystalline. A diamond is supposed by chemists to be carbon in its purest state: and charcoal may be considered as carbon, of which the properties and appearance are altered by the admixture of so very small a portion of some foreign ingredient, that it has never been detected.

"MARY.

"I understand you perfectly; but can you tell me why all the diamonds in the British Museum are cut into such curious forms? They are not like that in your ring. "MRS. L.

"Your question is very natural; but all the diamonds you have seen there are in their original state. When minerals are found in the form of regular geometrical solids, they are called crystals. Many of the other substances which you saw are crystallised.

"FRANCES.

"I think I have heard that crystal is a kind of flint; but you say the diamonds are crystals too.

"MRS. L.

"What is commonly called *crystal* or *rock-crystal* is, as you have been told, a kind of flint. It is, probably, the first substance ever noticed as occurring in a regular form. The ancients, on account of its transparency, believed it to be water permanently congealed by extreme cold, and called it *krustallos*, which means *ice*; but in time, the word was used without attention being paid to its original meaning, and was applied to other regular forms observed in minerals. At present, a crystal means (properly) a regular and symmetrical solid, produced by nature, or by the operations of chemistry.

"MARY.

"Is glass a crystallised substance? It is very much like rock-crystal.

"MRS. L.

"I am afraid you will not readily understand the difference between the crystallisation of glass and of the diamond. The particles of substances which crystallise are arranged with perfect regularity; and this must be the case with glass as well as with rock-crystal and the diamond, otherwise it would not be equally hard or equally transparent in every part. Common glass does not take any regular external form; but some particular kinds cooled very slowly, crystallise in tubes.

"FRANCES.

"Do all minerals crystallise?

"MRS. L.

"No; I could tell you the names of many which do not, but at present it would be useless to you to know them. However, if you wish to learn something of it I shall be happy to assist you.

"MARY.

"I am much obliged to you for the offer, and will certainly become your pupil; I should have been still more delighted with the minerals I have seen, if I had known anything about their nature.

"FRANCES.

"Is there any difference between mineralogy and geology?

"MRS. L.

"Yes; you must not confound them together. Mineralogy in its most extensive signification is the science of the unorganised mass of this globe, and comprehends a knowledge of the chemical, and also the external or physical, characters of minerals. This knowledge enables us to distinguish one mineral from another; geology leads us to explore the mountains and beds of stone of which the crust of the earth is composed, and to examine their peculiar relations and modes of aggregation.

"MARY.

"Do you mean that the earth is hollow, or filled with water, when you speak of the *crust*? "MRS. L.

"No; we know very little of the structure of the interior of the earth below the depth of a mile, which is the perpendicular extent of some of the deepest mines; and this, compared with the diameter of the earth, is not more than the peeling of an apple in comparison with the size of the fruit. The word *crust* is certainly not scientific, but it has been very generally adopted by geologists to express that outward part of the earth with which we are acquainted. "FRANCES.

"Then mineralogy and geology are quite distinct from each other?

"MRS. L.

"They are distinct; but still they are not independent of each other. Geology cannot be properly understood without the assistance of mineralogy; for how could you describe granite, slate, or limestone rocks, without knowing those substances?"

In this simple and pleasing manner, the arrangement of minerals, their individual character and peculiarities, and various other facts connected with mineralogy, are treated in succession, and in a manner very creditable to the knowledge and ability of the author. We would, however, correct a trivial error in the extract just given—it is there stated that we know but little of the interior of the globe "below *the depth of a mile*, which is the perpendicular extent of some of the deepest mines." Now, the deepest point to which the miner has ever penetrated is rather less than three thousand feet, being, therefore, very little more than *half a mile* in perpendicular depth. We also feel some doubts of the propriety of an expression elsewhere used by the author, in stating that "no 'ore of brass' has yet been discovered, but it may perhaps exist;" the meaning is obvious, but we conceive the term *ore* to be here misplaced.

To the general accuracy and ability displayed throughout the work, we have much pleasure in bearing testimony, the portion which relates to crystallography is extremely well executed, and illustrated by a large number of plates. The uses and applications of mineral substances are concisely noticed, and all the information consistent with the plan of the work is lucidly arranged and brought together. The work, although generally useful to learners, is of course peculiarly adapted for ladies, and those who reside in mineral districts, or have convenient access to mineral collections, will find it a pleasing and instructive companion in their leisure hours.

Loudon's Magazine of Natural History. New Series. Conducted by EDWARD CHARLESWORTH, F.G.S. Longman, London.

Several numbers of this very interesting work are now before us, which fully maintain the reputation of their predecessors, both as regards matter and embellishments, and we congratulate Mr. Charlesworth upon the success which has attended his spirited exertions in conducting the present series. Among those articles which have more particularly attracted our attention, we may briefly notice one, translated from the German, on the structure of fossil saurians, the Rev. W. B. Clarke's illustrations of the geology of the south-east of Dorsetshire, and illustrated zoological notices by the Editor; we may also notice a series of ingenious communications from many different sources on the origin of that singular and, as yet, perhaps, unexplained phenomenon, the "ignis fatuus."

From these we extract the following precise and well-authenticated statement, observing that the writer's opinion of the phenomenon resulting from the disengagement and spontaneous combustion of gaseous matter, principally hydrogen, from low marshy places, is, in our opinion, the most rational and consistent explanation that has yet been offered:—

"The July Number of your Journal is just lying before me; and, among the many interesting articles it contains, I have found one which, I think, ought to be refuted, as it tries to explain the phenomenon of the Ignis Fatuus by the phosphorescence of insects. From your remark at the end of the article, it sufficiently appears how little you are swayed by the opinion of the author. However, I have observed the meteor too well myself to give the least credit to any attempt of ascribing such effects to such causes; not to mention that the season at which Ignes Fatui are commonly observed (November) is one when scarcely an insect, except the Phalæna Noctua brumaria, is able to stir. The light of the fire-fly, though moving, is but a spark, and that of a glowworm does not change its place.—As for the mole cricket, it certainly haunts boggy meadows; but the insulated observation of a farmer of Simpringham cannot, I think, militate against the negative testimony of the many who, like myself, have kept that animal in confinement during long periods, without observing in it the least phosphorescence. I may say that I have taken great trouble, and spent many a night, to observe the Will-with-a-wisp in its haunting-places; yet, though in dark and misty weather I had often seen lights moving, and had many a time fallen into swamps and quagmires, I had never come near enough what I thought a Jack-o'-lantern to observe it closely, or even to become fully convinced of the existence of the phenomenon from my own experience. However, in the year 1818, I was fortunate enough to get a fine view of the Ignes Fatui operating on an extensive scale. I was then at Schnepfenthal, in the Duchy of Gotha; and in a clear November night, between eleven and twelve o'clock, when I had just undressed, the bright moonshine allured me to the window to survey the expanse of boggy meadows which spread two or three English miles in length, by a quarter of a mile, from the foot of the hillock on which the house where I was is standing. Through the first third of the meadows there runs a winding rivulet, of the breadth of seven or eight feet, which then turns off into an artificial bed, whilst the old bed continues in the direction of the meadows, which are bounded on one side by a range of brush-wood, on the other by cultivated grounds, with marshy dells here and there. My intimate acquaintance with the locality, together with the bright moon-shine, enabled me to discern every object round the meadow-ground sufficiently well to judge of the position and direction of the luminous phenomena, the display of which I saw, as soon as I had posted myself at the window. I perceived a number of reddish-yellow flames in different parts of the expanse of almost level ground. I described, perhaps, no more than six at a time; but dying away, and appearing in other places so rapidly, that it was impossible to count them; but I should say, on a rough estimation, that there were about twenty or twenty-five within a second. Some were small, or burned dimly; others flashed with a bright flame, in a direction almost parallel with the ground, and coinciding with that of the wind, which was rather brisk. After having for some time looked with amazement at this brilliant scene as a whole, I tried to study its details; and soon found that the flames which were nearest originated in a quagmire, whose position I knew exactly, by a solitary cluster of willows; and I could trace a succession of flashes from that spot to a certain point of the margin of the wood, across the rivulet and meadow. The distance of the two points from each other was more than half a mile, and the flames travelled over it perhaps in less than a second. The first flash was not always observed in the immediate neighbourhood of the quagmire; but the succession of flames lay always in the same straight line, and in the direction of the wind; whilst other sets were, though not with the same distinctness, observed in the more distant parts of the meadow-ground. After about an hour, a bank of mist began to overspread the meadow; but I saw the light still glimmering through it, whilst I dressed myself to examine the phenomenon in its laboratory. However, when I reached the meadow, the atmospheric conditions which gave rise to the Ignes Fatui had ceased to exist. From what I saw, I must judge that the Ignes Fatui are owing to the causes given by Volta; viz., that the phosphoric hydrogen exhaled by certain swamps is kindled by coming into contact with the atmospheric air; but, as the hydrogen is not saturated with phosphorus, the greater proportion of the latter being precipitated, in passing through the water, as red oxide of phosphorus, there is a certain electrical tension of the atmosphere necessary to cause the combustion. Thus, under common circumstances, the gas is dissipated without being observed; but, when the state of the atmosphere is competent to effect its combustion, the proper degree of electrical tension is lost at the place where an explosion is effected; and, until it is replaced, or the gas comes into contact with that layer of the atmosphere which possesses the requisite degree of electrical tension, a considerable body of bog-gas may collect, and be carried in the direction of the wind, so as to give afterwards rise to a sort of quick fire, with occasional flashes, in those places of the stream of gas where there happens to be a considerable volume of it. In calm nights, the flames may play in a vertical direction, so as to imitate the motions of gnats; and they may even *appear* to alight on some object; though, when this has been observed, it is more probable that the case has been one of the St. Elm's fire."

The following remarks, from the pen of the venerable Dr. William Smith, the father of British Geology, will, we are assured, be read with interest:—

"On March 31, 1836, I discovered that the finest particles of mica and quartz in stone, may be readily distinguished, without the aid of glasses; and, conceiving that this simple method of knowing the difference in some of our most common minerals, may be serviceable to geologists, I beg the insertion of it in your most useful magazine.

"With this view, therefore, without attempting any philosophical explanation of the phenomenon, I merely relate the circumstances of its practical application: first, observing with pleasure, that the eye, which gives us the power of knowing so much, and of knowing one thing from another so distinctly, without our being able to explain how we make the distinctions, is happily receiving from Sir David Brewster, and other philosophers, eminent in optical science, that attention it is entitled to.

SUPPLEMENT

"My sight has been particularly good, having been able to distinguish objects very clearly, near and at a great distance; and now, in my 69th year. I can distinguish a small speck of mica in a brown-red sandstone, at the distance of four yards; and *in the full bright light of the sun*, the brilliant reflections from facets of much smaller crystals of quartz. I was led to this experiment by finding amongst our Scarborough gravel, a brown-red sandstone pebble, the crystals of which brilliantly reflected the full light of the sun. Viewing it in the house, on a table before my window, with my spectacles on, and the addition of a small pocket lens, the glistening specks appeared too small for me to decide whether they consisted of quartz or mica; but, as I had lately selected from the same gravel specimens of mica slate, and mica sandstones, of all degrees of fineness, it occurred to me that small specks of mica were always visible without the sun's full bright light. I found them so; and, by collating the sandstone with the finest grained micaceous specimen, both on one piece of paper, shifted alternately into the bright and shady light of the sun, we have a clear and ready distinction between the finest grains of mica and quartz, without the aid of glasses, and that even at the distance of four yards.

"In my practical observations on the different kinds of land, I had long observed, by the glistening in footpaths, how we may readily distinguish the finest sand in soil: and, at Harrowgate, I have often amused myself, on the nicely sanded footpaths about the Swan Hotel, by fixing my eye upon any detached crystal (of mill-stone grit), which brilliantly reflected the light of the sun, and not without speculating on the application of such brilliant reflections to some useful purpose: but, in geology, the brilliancy of those facets of quartz crystals in our coarsest sandstones, seems to render doubtful the 'theory of sandstones being derivative rocks.'"

The illustrations of the "Magazine of Natural History" are clear and well executed, and great neatness is displayed in the typographical arrangement of the work, thus forming a yearly volume which must be duly valued by all who take an interest in the delightful study to which it is devoted.

Railway Magazine and Annals of Science. New Series. By JOHN HERAPATH, Esq. Wyld, London.

The Number of the *Railway Magazine* for the present month, with one or two of the preceding, are now before us, and contain an average quantity both of original matter, and of official reports, together with a fair proportion of scientific and miscellaneous intelligence. The principal contributions by the Editor are on the "Principles of Levelling," and on the "Amended Railway Standing Orders," addressed as a letter to the Duke of Wellington.

On the inadequacy and defectiveness of the present system of investigating the merits of competing lines of railway by Parliamentary Committees, we long ago expressed our opinion, when remarking on the disposal of the memorable Brighton lines in the last Session. Mr. Herapath's observations are pretty much in accordance with our views, as regards the necessity of altering this system, although expressed in stronger and less measured language than we would have wished.

We extract the following concluding remarks from this letter:—

"The question is, should railways be unnecessarily fettered with obstructions? Above all, should they be subjected to the enormous Parliamentary expenses which they are? We have been informed, by gentlemen whose information, we think, may be relied on, that the total expense for obtaining the bill on the Brighton lines, will fall little, if any, short of 300,000*l*. Ought so shamefully extravagant an expenditure to have been permitted? Are not the whole circumstances of this case alone proof irrefragable of the utter unfitness of Parliamentary tribunals for railway questions? Why, then, are they continued? Must the public believe that there are some sweets about them which cannot be parted with? Exert yourself, my Lord Duke, we beseech you, to convince the world that it is not so, by getting railway questions out of the jurisdiction of Parliament. Send them to the courts of law; send them to a commission; send them any where, even to a council of cobblers, rather than let them remain under such injudicious and expensive control."

We may also notice a report of some length by Dr. Lardner, "On the Motion of Trains on Railways," which was laid before the British Association at Liverpool, and is printed in the Number of the Magazine for the present month. The subject is one of much interest, but of course the mathematical reader only can follow Dr. Lardner's reasoning.

INSTRUCTIONS FOR TRAVELLERS.—In the instructions drawn up by the scientific men of France, for the use of the two vessels, the *Astrolabe* and the *Gelée* which are about to circumnavigate the globe, we perceive that Mr. Ward's plan of transporting plants is highly recommended, as well as that of Mr. Luschnath, which can also be applied to seeds, in order to preserve their germinating powers. M. de Blainville eagerly requires microscopic marine animals, the Spirula with its inhabitant, that of the *Nautilus flammeæ*, which is wanting in the collections in France, parasitical insects, and worms; and strongly urges experiments to be made on the temperature of living man, and beings of an inferior order, under different circumstances. He also lays great stress on the possession of the Chionis from Cape Horn, &c., the animals of the extreme south, the probably fabulous horse of Molina, with its divided hoof, his articulated cuttle fish, and the Phytotomus. He sets forth the important novelties likely to be found in New Guinea, the Moluccas, and Celebes, in the creeks and bays of which, probably, exist a multitude of fishes and Mollusca, and particularly requests the acquisition of the Aptreyx, from the New Holland region, which is supposed not to have any wings, and which the inhabitants call Kioi-kioi. Further information he considers necessary concerning the dentition of the Tenrees, on the Aye-aye, or the Cheiromys, and he terminates a long list of instructions by recommending naturalists to notice the contents of the stomachs of all those animals which they kill, and minutely to observe the number, form, and colour of the eggs of birds, reptiles, fishes, articulated animals, and mollusca. M. de Freycinet recommends hydrography, observations on the tides and currents, such descriptions of the countries visited as will set forth their resources to future navigators, their statistics, and the moral state of their inhabitants. Physical observations are warmly urged by M. Savary, as forming part of the long series of observations which are required for the solution of various facts. M. Cordier states the ignorance which prevails concerning the southern hemisphere, and the consequent value of the smallest atom of rock from this quarter, and especially of any which can give a certain notion of the soils, which, under different meridians, advance towards the southern pole, and he invites geologists, to observe the direction and inclination of the different strata. To these he adds the observance and collection of fossil remains and marine deposits, with detailed notes concerning the position in which they are found, and the history of earthquakes and their visible consequences.

FOSSILS FROM ORAN.—At the sitting of the French Institute of October 9th, M. Duvernoy read a paper on several fossil teeth, received from Oran, and presented fragments of osseous arenaceous deposit from that region. He observed, that this fragment confirmed the existence of similar deposits on the African and European shores of the Mediterranean. It contained osseous remains which were too mutilated to enable him to distinguish what animals they belonged to; a fragment of a tooth evidently belonging to a ruminating animal; and several isolated teeth belonging to fishes. The white rock in which these teeth are found, belongs to the superior part of the second tertiary layer, formed, says M. Rozet, of coarse calcareous materials, showing themselves at the surface of the soil, through the whole extent of the plain to the south and west of Oran. The inferior part of this layer is composed of calcareous chalky beds, alternating with beds of yellow schistus sandy marl. There are above two banks, a yard in thickness, situated at a small distance from one another, and composed of very white schistus marl, in which incomplete skeletons of fossils are very numerous. It is remarkable that all the fossil skeletons of fishes examined by M. Agassiz, at Algiers, belong to one single species, the *Alosa elongata*, as if whole shoals of this fish, like the herring of our times, had been involved in one common catastrophe. Teeth only, detached from the skeleton, without any fragment of the lattter, have been discovered in the upper part of this second layer, and M. Duvernoy considers the greater part as having belonged to the genera Chrysophris and Sargus.

EXTRACTS FROM FOREIGN SCIENTIFIC WORKS.

No. XVI.

ON ISLANDS PRODUCED BY VOLCANOES.

The writers of antiquity often speak of islands which were seen to rise from the bosom of the seas in the vicinity of Greece. The famous islands of Delos and Rhodes, says Pliny the naturalist, are said to have risen from the waves; and smaller ones have since appeared, such as Araphé, beyond Melos; Nea, between Lemnos and the Hellespont; Alone, between Labedos and Theos; Thera and Therasia, among the Cyclades in the fourth year of the 135th olympiad; Hiera or Automate, lying between the two former, and formed 130 years afterwards. In more modern times, 110 years after, in the consulship of M. Junius Silanus and L. Balbus, on the eight day before the ides of July (the nineteenth year of our era), Thia made its appearance (Book 2d, cap. 88 and 89). We observe, with regard to this passage, that Pliny only gives the origin of Delos and Rhodes as a simple tradition—which origin we know was connected with the ancient mythology—that the same doubt hangs over Araphé (now called Namphio), which we have known to take place in the same seas at the beginning of the last century, gives great credibility to the origin ascribed to Therasia, Hiera, and Thia; that Thera (now Santorin), according to the remarks of Perè Hardouin, already existed, at least in part, at the epoch above assigned to its formation, and this existing part is calcareous. Strabo positively asserts, that Hiera was produced in the midst of flames: "At a point between Thera and Therasia," says he, "flames darted forth from the sea for the space of four days, so that the whole sea was in a state of ebullition, and gradually produced an island formed of masses raised as it were by mechanical forces, and twelve stadia in circumference." Plutarch and Justin report that its formation was accompanied by abundance of fire and a great boiling of the sea. Seneca has transmitted us an exact account of the formation of these islands in the Archipelago. He states, that they were produced by the aggregation of the stones thrown up into the air by volcanic agency, in some instances without their being changed materially, in others after they had been reduced to a fine powder, and that at length the summits of these heaps of stones appeared above the waves. The following is his description:—"In the memory of our ancestors," as Possidonius states, "an island arose from the Ægean sea, the waves all the while foaming, and a vapour ascending from the deep. At length fire burst forth, which appeared at intervals only, like lightning, whenever the heat of the lower strata overcame the resistance of the superincumbent weight. Then stones and rocks being emitted, partly broken into pieces, when the volcanic agents had expelled them before changing their form, and partly rendered porous and light as pumice-stones, the top of the newly formed mountain appeared, which increasing in height, the rock assumed the magnitude of an island. A similar circumstance occurred in our own times, during the consulship of Valerius Asiaticus (A.D. 47)."—*Quæst. Nat.* vol. ii. c. 26.

After these testimonies, it is evident that all the islands of the Grecian sea, which the ancients declare rose out of the water, are only the summits of volcanic mountains. Full details of these islands are given in the learned treatise of M. Raspe, entitled "Specimen Historiæ Naturalis Globi Terraquei præcipue de novis e mari natis insulis;" and in M. Malte Brun's chorography of Greece, inserted in the tenth volume of his "Universal Geography."

Similar phenomena have since recurred at different periods in the same seas. It appears that in the year 726 the island of Hiera received an increase, and that in the year 1457 or in 1575 a new islet was formed in the gulf of Thera, in the midst of volcanic convulsions, and nearly on the same spot where Thia appeared, in the consulship of Silanus, and which was afterwards submerged by the waves. Lastly; at the beginning of the last century, another island arose among those already existing. As we are possessed of authentic particulars of this singular phenomenon, which may enable us to form a judgment with respect to others of the same description, we offer our readers an abridged account of the principal circumstances attending its formation.

On the 25th May, 1707, at sun rise, a floating rock was perceived in the sea, at a league's distance from the island of Santorin. It was taken by some sailors for a vessel on the point of being wrecked, and proceeded towards it with the design of plundering it. Seeing what it was on a near approach, they had the courage to land upon it, and brought away with them some pumice-stone, with oysters adhering to it. The rock seemed nothing but a mass of pumice, which the earthquake occurring two days before had detached from the bottom of the sea. In the course of a few days it became fixed, and thus formed a small island, which increased daily in size. By the 14th June it was 800 yards in circuit, and seven or eight in height, being of a round shape, and composed of a white and very light mineral substance. At this period the sea became agitated, and a heat was felt on the island so great as to forbid access; a strong smell of sulphur being perceptible all around. On the 16th July about seventeen or eighteen black rocks appeared; and on the 18th, for the first time, a thick smoke was emitted, and subterranean hollow sounds or moanings were heard; on the 19th fire began to appear, and its intensity gradually augmented. During the night the island seemed to be filled with furnaces vomiting flames, the power of which continued increasing until the odour emitted became insupportable at Santorin. The sea now boiled violently and threw dead fish on the shore; the subterranean noises resembled the discharge of numerous pieces of artillery; the fire made fresh openings, whence showers of cinders and hot stones were thrown up, in some instances to a distance of more than two leagues. This state of things continued for a whole year (see the "Histoire de l'Academie," 1708).

On the 15th July, 1708, Father Gorré, a Jesuit, approached the island, and the following is the account he gives of his voyage:—"We took care," he says, "to provide ourselves with a boat with well paid seams, and approached the island on the side where the sea was not in ebullition, but where, however, there was abundance of smoke. On putting our hands into the water we found it was boiling, being then still 500 feet from the island. There being no chance of getting onwards there, we turned towards the promontory most distant from the large crater. The fires still bursting out, and the sea sending up large bubbles in that direction, we were obliged to make a long circuit, and yet we suffered extreme heat. We landed at Grande Camœni (Hiera), and were enabled to examine the new island without much inconvenience. It might be 200 feet high, a mile in width, and about five miles round. On our return to Santorin our sailors observed to us, that the heat of the water had melted almost all the pitch of our boat, which was beginning to open at all the seams."

M. de Choiseul, who visited the spot in 1776 says, that during ten years subsequent to its formation, the volcano of the new island had several eruptions, but that it is now entirely quiescent. "The water," he remarks, "is not hot anywhere about; no exhalation is perceptible; there are only observed a great quantity of bitumen and sulphur, which becoming disengaged from the sides of the island, float about on the water."

The island of Santorin, which is about eight square leagues in extent, forms an immense semicircular bay, of four leagues diameter, the depth of which has not been sounded. The whole circle, if traced, would pass through the island of Therasia (now Aspronysi), which follows the curve. In the middle are found the three islets of which we have spoken; they are called "Iameni," that is to say, burnt. The rocks bordering the bay are black, calcined, vitreous, and of the nature of obsidian; they rise to more than 200 yards above the level of the sea; the remaining part of the island is calcareous. It appears from this that the bay is an ancient crater, of vast extent, a part of which has plunged downwards into the sea; that Therasia is a remnant of its edge—that the volcano to which it belongs is still burning under the sea—and that in its great crises it has produced the three small islands in the centre. As to Santorin, it appears that very far from deriving its origin from subterranean fires, as might be inferred from the passage quoted from Pliny, it has been, on the contrary, torn asunder and almost annihilated by them—(see the maps of these islands and of the bay in the splendid work of M. Choiseul, "Voyage Pittoresque de la Grèce.")

The archipelago of the Azores has occasionally exhibited the same phenomena as that of Greece. In 1638 an island appeared near St. Michael; in 1720, after a violent earthquake, another was formed between Terceira and St. Michael, which emitted a great quantity of smoke; the bottom of the sea in the vicinity was found to be extremely hot; the height of the island, which at first was so great, as to be visible six leagues out at sea, soon sank so considerably, that in 1792 it was on a level with the sea.

In the year 1783, a great smoke was perceived at the south-west coast of the island, and the sea was covered with pumice-stones to several leagues distant, when there arose, near the land, a small island, vomiting a prodigious quantity of flames and pumice. Its longitude and latitude were noted, and the King of Denmark gave it a name; but the following year, when, by order of that Government, a new survey was about to be taken of it, it was ascertained to have disappeared.

A new island likewise arose a few years since, on the coast of Kamtschatka. On the 10th May, 1814, at about two o'clock P.M., the weather being calm and clear, a great noise was suddenly heard; and at about 400 yards from the shore, flames and thick smoke were seen to rise out of the sea, with explosions resembling the discharge of cannon. Enormous masses of earth and large stones were violently hurled into the air. This continued until evening, when a small island was seen to be formed, which emitted bitumen by several openings. Ten days afterwards it was visited, when some difficulty was experienced at first in approaching it on account of the hardened bitumen which surrounded it. The surface was found to be three yards above the level of the sea, and was entirely covered with a whitish and stony mass.

Such are the principal facts which history has transmitted us in regard to islands produced by subterraneous fires. We find that they are only aggregations of pumice-stones and of scoria, which the volcanic agents have heaped on each other; and that not unfrequently the falling asunder of these disjointed materials has soon afterwards immerged these islands under the waves whence they sprung.—*Karsten's Archiv.*

FORESTS IN IRELAND.

We quote the following from an interesting paper in a late number of the *Dublin University Magazine*, treating on the Forests in Ireland, the destruction of which are, it will be seen, ascribed to several causes; among others, however, the use of the timber in the manufacture of iron, as the ruins of the numerous "bloomeries" in various parts of the country afford ample testimony, must also be taken into consideration. There cannot be a doubt, but that Ireland at one period produced large quantities of iron, comparatively speaking, and from the "bloomeries" which were in use, for the manufacture of iron from charcoal, antecedent to the introduction of pit coal, and the abundance of ironstone generally throughout the kingdom, there can be no doubt, but that a large proportion of timber was cut for this purpose. The subsequent introduction of bituminous coal, which has been, and is now, applied at the Arigna Works, in the county of Roscommon, will, we doubt not, still render Ireland independent of other countries for its supply, if that economy be used—as of its quality we believe there is no question. We hope that some correspondent will favour us with information on this point, while we may observe a rival may be contemplated from the application of Mr. Crane's patent for using anthracite, or, as it is better known in the Sister Isle, Kilkenny coal.

"Forests abounded in Ireland during the reign of Henry the Second, and down to a much later period, Shillelah (*the fair wood*) in the county of Wicklow, was famed for its beautiful oaks. Mr. Hayes says, 'Tradition gives the Shillelah oak the honour of roofing Westminster Hall, and other buildings of that age; the timbers which support the leads of the magnificent chapel of King's College, Cambridge, which was built in 1444, as also the roof of Henry the Eighth's Chapel, in Westminster Abbey, are said to be of oak brought from these woods. The destruction of our forests did not proceed with rapidity till the commencement of the 17th century. Dr. Boate, whose history of Ireland appeared in 1652, complains of the disappearance of the woods. Such, he says, has been the loss of timber, that in some parts of the country you may travel whole days without seeing any woods or trees, except a few about gentlemen's houses, as, namely, from Dublin, and from some places that are farther to the south of it, and to Tredah, Dundalk, and the Newry, and as far as Dromore, in which whole extent of land, being above three score miles, one doth not come near any woods worth the speaking of, and in some parts thereof, you shall not see so much as one tree, even in many miles. Still, many extensive forests remained.'

"According to Boate, Wicklow, King's County and Queen's County, were throughout full of woods, some whereof are many miles long and broad. At this period, there were also great forests in Donegal, in Tyrone, and along Lough Erne, and in many other places in the province of Ulster. Peter Lombard, a Roman Catholic Priest, who published an account in Ireland, in the year 1632, states that wolves were so numerous, that sheep had to be penned up every night, to protect them from those ravenous animals. Wild boars abounded in the woods, which also swarmed with martins, so that the chief wealth of the country consisted in peltries. Such an abundance of wild animals required a corresponding extent of wooded country to afford them shelter. A few years later (1697) we find that wood was equally plentiful in Munster, for in that year a committee of the House of Commons estimated the injury done to Lord Kenmare's forests at 45,000*l*., and that those of Lord Massey, in Cork, had suffered to the amount of 25,000*l*.

"The publications of the Irish Record Commission contains some curious information respecting former abundance of natural woods in Ireland. The trustees appointed for the sale of the estates forfeited in the rebellion of 1668, estimated the value of the woods standing upon such estates, at about 60,300*l*. According to the same report, the woods upon the estate of Sir Valentine Brown, in Kerry, were cut down and wasted to the amount of 20,000*l*.; and on the late Earl of Clancarty's estate, now granted to Lord Woodstock, the waste of timber is estimated at 27,000*l*. So hasty have several of the grantees and their agents been in the disposition of the forfeited woods, that vast numbers of trees have been cut down and sold for not above sixpence a-piece. The like waste is still continuing in many parts of this kingdom, and particularly in the lands of Fettrim, within six miles of Dublin, and the woods of Shagnessy, in the county of Galway, purchased by Toby Butler, Esq., for about 2500*l*., which were valued at above 12,000*l*.

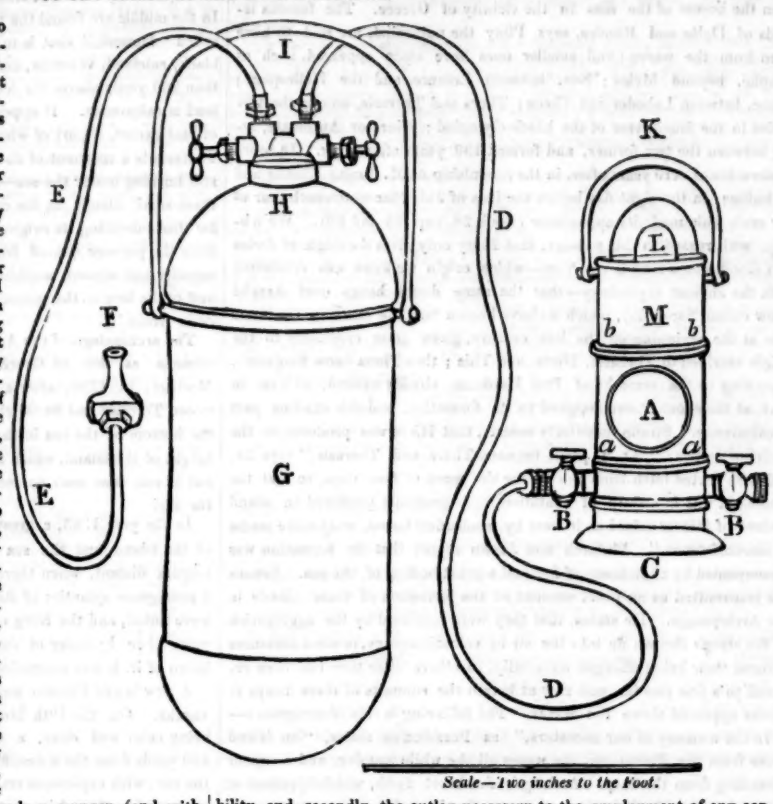
"But a better idea of the extent of the forests may be formed, when we examine the causes which led to their destruction. Great quantities of wood were formerly exported from Ireland. When Boate published his work, the exportation of pipe staves was one of the ordinary branches of industry, so as a mighty trade was driven in them. Whole ship loads were sent into foreign countries yearly, which, as it brought great profit to the proprietors, so the feeling of so many thousand trees every year did make a great destruction of the forest in tract of time. In the year 1669, the Earl of Strafford furnished Lawrence Wood, of London, with pipe staves to a great amount, at the rate of 10*l*. per thousand."

ORIGINAL CORRESPONDENCE.

MESSRS. G. AND W. BURSILL'S LIFE LAMP AND LIFE APPARATUS.

TO THE EDITOR OF THE MINING JOURNAL.

Sir,—The French engineer, Le Bon, to whom has been ascribed the merit of first applying carburetted hydrogen to the useful purposes of illumination, in bringing that subject before the public, makes the following observation:—"To have some extraordinary effects to announce to the public, I feel at this moment to be an embarrassing situation—those who did not see them exclaim against their possibility, and those that have seen them, frequently judge of the facility of an invention by the ease of conceiving the demonstration. The difficulty of conception being scarcely surmounted, the merits of the invention either vanish or lose much of their value; yet I would rather sacrifice all idea of merit, than leave the least idea of charlatanism existing in the mind of the public." We cannot but feel, Sir, that the remarks of Le Bon apply forcibly to our own case. Upon first announcing our readiness to descend into any part of a mine, however strongly its atmosphere might be impregnated, either with fire-damp, black-damp, or even choke-damp, we have seen the smile of incredulity playing upon the lips, as well of the scientific as of the practical man; while some were not wanting, who warned us that a fate must inevitably await us, not less melancholy than that which, in attempting another of these, as yet, unfrequented paths of science, has befallen the late intrepid, but unfortunate adventurer, Mr. Cocking. We hope, however, to see the time, when this hydra-headed monster, this fire-damp, with its attendant evils, shall be totally and literally beaten under our feet; for as to any alleged impracticability of carrying on any necessary operations, even amidst the most deleterious gases, or of lighting up in safety the fiery coal-seam, we do not hesitate to say that, we will take even the most foul of them, and by the aid of the instrument we are now about to describe, will light them up in such a manner (and with portable gas, if required) as to render them almost as light as day. In order, Sir, to overcome the great variation existing in the atmosphere of mines, it occurred to us after much labour and hard application, that the only way to obviate completely such difficulty, and to form what might be justly termed a life lamp, or a lamp that should be proof against, and, therefore, useful in, the most sudden and dreadful contingencies, was to contrive a means by which such lamp should, if possible, be thoroughly and even readily portable, though supplied with, and therefore constantly consuming a stream of pure atmospheric air; hardly doubting, that a lamp possessing such properties, must in times of emergency, at all events, prove the great desideratum. The invention consists, then, of a new application of condensed atmospheric air, in portable metallic cylinders, to the support of light and of life, either separately or conjointly, and for subterranean purposes.* The drawing, we have the honour of sending for your inspection, is a representation of the life lamp, with its accompanying and flexible life-tube, or life apparatus.



Scale—Two inches to the Foot.

In the centre of the lamp is a strong lens, marked A; the upper part of the lamp containing the lens, unscrews at *a a*, and discovers above and around the oil vessel, C, certain internal arrangements, by the aid of which, every particle of air coming into the lamp through the arm B, goes direct to the wick, and is there consumed. The arm B, and its accompanying stop-cock, are connected, by union with an Indian rubber tube, D D D, the remaining end of the tube being affixed (also by union) to a double inlet and exit cock, marked H. G is a portable cylinder, made of wrought-iron, and filled with compressed atmospheric air, being charged up to about thirty or forty atmospheres. The full size of this cylinder, as will be seen by reference to the scale, is one foot in length, by eight inches diameter in the cylindrical part, with the addition of hemispherical ends; it contains a sufficient quantity of air in the state of compression just described, to support continued combustion for full two hours. To one part of the double cock, H, may be attached, at pleasure, a second flexible tube, E E, terminating in an ebony mouth-piece, F, through which the miner can procure, when exploring any place where there is an imminent danger of suffocation, any quantity of pure air that may be required for respiration. The operation of breathing through this mouth-piece is somewhat similar to that of smoking a pipe, any portion of impure air finding its way through the nostrils being, in general, so much diluted by the pure air, as to be rendered harmless; but precautions may be taken, if working amidst gases that excite very violent coughing, to stop the nostrils altogether.

I will not, at present, enter into a minute description of the double exit and inlet cock, H, as it is found applicable to other purposes, and steps are, on that account, now in progress for securing this part of the invention by patent-right; suffice it to say, that, by a peculiar, though, in fact, very simple internal arrangement, its action is such, that the air, passing from the cylinder G to the support of the flame, is at all times supplied in one uniform volume or stream, until the cylinder is exhausted. The remaining arm, B, and its accompanying stop-cock, are attached to the lamp, in order to facilitate the operation of removing it from one cylinder to another, without affecting the light; for, at the point of operation, it is desirable, as early as possible, to bring up other, and much larger, though still portable cylinders; and such cylinders should, in fact, be kept at all times ready charged, and placed at certain approved stations in the mine, to be ready in case of need, and will occasionally be found extremely serviceable in promoting the ventilation of any very confined place. The small cylinders are termed explorers—the large are called the working cylinders; these latter are about three feet in length by one foot in diameter, in the cylindrical part, and contain a sufficient quantity of air, in a state of compression, to support a light for twenty-four hours. The manner of charging them is by the aid of force-pumps. The exploring cylinder may be suspended from one hand (when walking) by its handle, I, the lamp being carried in the other, and being moveable in every direction with the greatest facility; but when attached to the large or working cylinders, the lamp may either be placed upon the ground or suspended from the roof or wall, in any of the usual ways, by its handle, K.

The chimney, L, is bent downwards, to prevent any thing falling into it, as water from the roof; it is also made somewhat taper, so that the rush of the smoke may effectually prevent the ingress of any inflammable air. To render this part more secure, a layer of wire gauze is inserted at *b b*; and we have still further been careful to guard upon this point, in a manner that cannot fail, we think, to give confidence even to the most timid, since we have surrounded the chimney with a vessel or cup, M, which, when working amidst fire-damp, can be filled up with water, so as to form a sort of water-joint, through which the smoke keeps ascending in bubbles as fast as generated; nor is this arrangement found to cause any disagreeable flickering of the light. It is advisable to have an additional double cock inserted into the bottom of some of the small cylinders, as such cock is calculated to be of especial service in cases of black-damp or of choke-damp, inasmuch as it admits of the application of two additional life tubes or mouth-pieces (which the miner can carry in his pocket), and by the aid of which immediate relief can be given to such as are in a condition to take advantage of it. Another form of the apparatus, adapted for especial service amidst choke-damp is, to have the cylinder strapped to the back or shoulders, in a manner similar to a soldier's knapsack, the lamp being attached to a belt that goes round the body, leaving both hands at liberty to assist the sufferers. One or two of these instruments only, kept always ready for immediate use, will serve for the prevention of many horrid contingencies.

It cannot escape observation, that there are two circumstances that must operate prejudicially against any general or exclusive adoption of this lamp for mining purposes. First, the comparative want of portability, and, secondly, the outlay necessary to the employment of any considerable number of these lamps, involving, of course, the employment of some additional machinery. It is for this reason that we have announced it as especially applicable to all the more difficult and peculiarly hazardous operations, as in the approach of old works—in the trying or setting to rights of an abandoned or long-neglected mine—in the draining of blowers and of goafs (or natural gasometers of carburetted hydrogen)—in the formation and repairing of the air-courses, or gas-drifts—in operating amidst either black-damp or choke-damp—and, in short, in all cases of peculiarly trying difficulty and danger, arising from the presence of deleterious gases.

The experiments made, with a view to ascertain the practicability of this method, are extremely favourable; the supply of atmospheric air necessary to the support of continued combustion, being not more than about half a gallon per minute; nor is the expense found to be so great as might at first be imagined. Three or four lamps only, with as many of the small, and about half-a-dozen of the large cylinders, and a small force-pump, will be found to be of essential service; whilst about half-a-dozen lamps, and from a dozen to twenty cylinders, in many cases would be ample; and these, with a pair of our improved force-pumps, to be worked by a band from the steam-engine, can be supplied by us at a cost (considering their utility) altogether inconsiderable. The power required to supply any given number of these lamps, must of course depend upon the degree of condensation. If the number of lamps is at all large, and the degree of condensation we recommend is employed, that power must, of course, be very considerable. But let it not be forgotten, that atmospheric air costs nothing, and steam next to nothing, at the mouth of a coal mine. The expense, therefore, where circumstances render the employment of this lamp at all necessary, are by no means of a kind calculated to enhance the existing price of coal, nor is the invention, on the other hand, greatly calculated to depress it. It will enable the coal-owner to carry on many of the more expensive and hazardous operations, with something like certainty as to the ultimate result; it will enable him, in some few instances, to exhaust almost entirely his rich coal seam, without the necessity of sinking an additional shaft (being proof against any blast or current that it may be necessary to keep against the face of the works, for the purpose of ventilation, however violent); nor should it be considered, amongst the least of its advantages, that the principles upon which it is dependent for safety, are of so self-evident a nature as to be readily understood, even by uneducated men.

We have now, Sir, through the medium of your most valuable assistance (for which we beg to return you our sincere and grateful acknowledgements), had an opportunity of laying the result of our labours before the mining interest generally.† Whether our exertions will meet with due encouragement from that body, remains yet to be seen. How far our double and proof Davy lamps may be calculated to supersede the valuable lamps already in use, is a matter which, as Mr. Upton has very properly observed, ought by no means to be decided by any opinion that may be formed of them by the inventors; nor can it, in fact, be determined by any thing short of long and continued trial in the mines. There is one point, however, that we are anxiously desirous to establish—one thing that we are earnestly desirous to impress, as well upon the mining interest as upon the Legislature, and, upon the country at large—a matter upon which, we think, there can be but one opinion, intimately connected as it is, as well with the interests of humanity, as, in fact, with the real interests of the coal-owners themselves, inasmuch as it will not only exempt them as well from those frequent and heart-rending spectacles, but also from those terrific losses that are entailed as the effects of those dreadful explosions—it is this; that at the point where the lamp of Messrs. Upton and Roberts, or any other "real safety lamp" goes out, the life lamp ought to be employed, and we shall then have a complete protection from fire-damp.—We remain, Sir, yours, very truly,

9, Bury-street, St. James', Oct. 25. G. and W. BURSILL.

* With certain modifications the invention is applicable also to the support of life for subaqueous purposes.

† We shall shortly have the pleasure of communicating some recent improvements in our Proof Davy Lamp, by which the three qualities—of portability, simplicity of operation, and a brilliant light to the miner (so forcibly recommended as the desiderata by Mr. Upton)—are, we think, attained in an eminent degree. We will only now observe, that it is by a particular use of that very beautiful substance, mica (commonly called talc), to which you recently called the attention of your readers.

THE DAVY LAMP.

TO THE EDITOR OF THE MINING JOURNAL.

"All that science has hitherto done for us, with the single exception of the Davy Damp, is to give us a light which goes out at the point at which we most want it."—BUDDLE.

Sir,—Your courteous and intelligent correspondents, Messrs. Bursill, by reporting the above observation of Mr. Buddle, afford what the Parliamentary Committee could not give—the reason why the coal owners of Durham and Northumberland prefer the Davy Lamp to any other lamp. That the preference should rest on its possession of a property never exercised without injury to health, nor frequently without loss of life, will surprise those who consider that wealth should never be obtained by unjust means, much less at the sacrifice of the health or the life of others. In common justice to the coal owners, it must be admitted that no one but Mr. Buddle, nor has even he, I believe, except in the present instance, ever openly acknowledged the cause of this hitherto unaccountable preference. It will be seen by the "Book of Evidence," published (unfortunately for the working collier) by the above committee—a book but little read—that all the witnesses connected with coal mining, amongst whom Mr. Buddle rather makes a prominent figure, disclaimed the notion that the working colliers were ever willingly placed or kept in an unwholesome atmosphere. They stated to the committee what Mr. Buddle had before stated to the coroner's inquest, on the Walls End explosion, that the workmen were invariably ordered to withdraw as soon as possible from places where the Davy Lamp filled with flame, which it always does in an atmosphere vitiated with carburetted hydrogen. They, moreover, affected to lament their inability to enforce this order, which was too frequently neglected by their workmen, who, it appeared by their representation—or rather misrepresentation—were eager to take every opportunity of getting suffocated or burned to death. So readily is that believed, which ought to be true—I mean the anxiety of the coal owners for the safety of their workmen—that the committee were, as well as others not in the secret, completely imposed upon. As a proof, Mr. Pease, the chairman, observed, when Dr. Birkbeck described our lamp as possessing this now so highly valued by Mr. Buddle (see Question 3908), "Then the precaution which is taken, or which is asserted to be taken, of compelling the men to withdraw from work the minute their lamps (the Davy Lamps) become red hot, would not be necessary in the use of Upton and Roberts's lamp, the light being still preserved with safety?"—Dr. Birkbeck answered, "Certainly not." Mr. Pease further observed, "Is not the introduction of that lamp to be dreaded, considering the anxiety of the coal owners to obtain all the coal they can?" This observation had all the force on us that such an observation ought to have. We altered our lamp, and deprived it of a quality which we considered (and he appeared to consider) the only drawback on its usefulness. The result is now before your readers—its proscription by the coal proprietors of Durham and Northumberland. To show that we were not over sensitive in this matter, nor the only dupes, it will be seen that several ingenious persons (amongst whom must be named Dr. Clanny) had busied themselves in contriving means to extinguish the Davy Lamp, at the very point at which it seems Mr. Buddle considered it was most wanted to burn. Whether science would ever, unless humanity were lost sight of, supply this want of Mr. Buddle's, I much doubt; and I readily believe, could Sir H. Davy rise from his tomb, that he would be the first to repair his error in this particular matter, and to rebuke those who misled him and concealed the truth from him, "by attributing all accidents, since the introduction of his lamp, to the carelessness of the workmen" (see Note No. 4, Appendix to his pamphlet on Flame). It is most true that Mr. Buddle has been the chief actor in the Davy Lamp tragedy—ignorantly, I must in charity admit—but that he has been so, I am prepared to show; this obstinacy, therefore, in defending and persisting in, and attempting to perpetuate a system which has worked so destructively under his own direction, calls for severe condemnation. It will be seen, on reference to the Report of the committee, that they found, taking a period of sixteen years before and after the introduction of the Davy Lamp, that more persons had been destroyed by explosions in the counties of Durham and Northumberland, where it was presumed that this lamp had had the fairest trial in the latter than the former period. The list of accidents on which this calculation was made had been taken from "Sykes's Records," and was submitted to Mr. Buddle for correction. When Mr. Buddle, after its proper examination, presented it to the committee, he stated that he had found a few omissions, which he had taken the liberty of supplying; he added, and I shall use his own words, to prevent mistake, "I have designated those in which I have been personally concerned, by asterisks (*)." Those in which he was personally concerned mean, it must be presumed, the accidents which happened in the mines under his direction. Few, indeed are personally concerned in more than one explosion. The following statement will furnish the best commentary on Mr. Buddle's working of the Davy Lamp, and on the protection it affords the miner. It appears from the list already quoted, that the full number of deaths from explosions in the whole of the numerous mines of Durham and Northumberland, since the introduction of the Davy Lamp to the sitting of the committee, are 629, out of which 449 took place in eight mines marked by Mr. Buddle as under his management!!! "Facts" are said to be "stubborn things"—these facts I leave then for Mr. Buddle, and for those who pin their faith on his sleeve. Let them reflect on what they are now doing—another Walls End sacrifice of a hundred lives is surely not required to prove the insecurity of the Davy Lamp.

I remain, Sir, your obliged and obedient servant,

Nov. 1. G. UPTON.

P.S. I hope Mr. Thompson will excuse my giving Mr. Buddle the preference of a first notice.

HER MAJESTY'S STATE CARRIAGE.

The state carriage which conveyed the Queen to Guildhall, on the occasion of her Majesty's visit to the City, on Thursday last, is, we believe the same which was built for George the Third, soon after his accession to the throne. It is, therefore, nearly seventy years old, and has belonged to four successive sovereigns. The original cost of this splendid, but somewhat cumbrous vehicle, which is very rarely seen by the public, is thus stated in a work now before us, which minutely describes also the various items of the expense of building it.

"COST OF HIS LATE MAJESTY'S STATE COACH IN 1762.

Coachmaker	£1673	15	0
Carver	2500	0	0
Gilder	933	14	0
Painter	315	0	0
Laceman	733	10	7
Chaser	665	4	6
Harness-maker	385	15	0
Mercer	202	5	10
Bit-maker	99	6	6
Milliner	30	3	4
Saddler	10	16	6
Woollendraper	4	3	6
Cover-maker	3	9	6
	£7557	4	3"

TEMPERATURE OF THE EARTH IN HIGH LATITUDES.—The whole of Northern Siberia presents the singular phenomenon, that, even in the hottest season, the soil remains frozen from a certain depth downwards, differing according to the latitude, and other local circumstances, and that the thickness of this frozen stratum is so considerable in the more easterly places, as for instance, at Jakutzk, that its bottom has not yet been reached. Gmelin relates that in the archives at Jakutzk, he found an account of an inhabitant of that town having, at the beginning of the last century, together with some Jakuters, contracted to sink a well, and that, when they had reached the depth of ninety feet, finding the earth still frozen, they refused to fulfil their engagement. Some philosophers have considered this contradictory to the supposition that the interior of the earth is in the state of fusion. But from the following account it will be seen that, in those frozen strata, the general phenomenon of an increase of temperature with the depth is not wanting, and that by continuing the work, they have arrived at a temperature which leaves no doubt that they are not far from the lower limits of the frozen soil, and that water, the object of their undertaking, is not far distant. An article from St. Petersburgh, in the Berlin news of the 24th February, 1832, states that at Jakutzk, in Siberia, the earth, even in the hottest summer, only thaws to about the depth of three feet. Hitherto all attempts to discover the thickness of the frozen strata beneath, have been fruitless. Since the year 1830, one of the inhabitants of Jakutzk has been engaged in sinking a well, by which means it may, perhaps, be ascertained. In the same year the workmen reached the depth of seventy-eight feet below the surface, but still found no water. In the year 1831, they reached ninety feet, and were still in the frozen soil. The work is still in progress, and there seems no doubt of their attaining their object, for the thermometer, which showed 18 deg. 5 min., a few feet below the surface, rises, when sunk to the bottom of the well, to 29 deg. 75 min.—*Edin. Phil. Journal.*

ENTOMOLOGY.—A remarkably fine specimen of the locust species, supposed to be *Locusta migratoria*, was captured a few days ago in the neighbourhood of Leigh, in this county. When extended it measured nearly five inches across the wings, and two inches and three quarters from head to tail. It is in the possession of Mr. A. Edmunds, jun., of Worcester.—*Worcester Herald.*

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MINING JOURNAL. ONE SHILLING

The Mining Journal

AND COMMERCIAL GAZETTE.

SUPPLEMENT---XXVII.

REVIEWS.

A Treatise on Geology—forming the article under that head in the seventh edition of the *Encyclopædia Britannica*. By JOHN PHILLIPS, F.R.S., F.G.S., &c. &c. Black, Edinburgh. 1837.

The works of Professor Phillips must be well known as forming a valuable accession to geological science, and possessing, in an eminent degree, that acute discrimination and power of generalization which have now become of so much importance in advancing this important branch of human knowledge. Qualified no less by a thorough practical acquaintance with the phenomena of geology, than by a general and extensive knowledge of other branches of science which are connected with it, he distinguishes at once between ascertained deductions, established facts and generalizations, and those obscure investigations, as yet almost unapproached, or waiting for solution till the result of present inquiries be more fully known.

The work before us well exemplifies the qualifications to which we have alluded, and we have seldom been more gratified than in perusing its luminous and instructive pages, which contain the most comprehensive view of the general bearings and present state of geological science which has yet issued from the press, although of course embracing but few minute facts or local details, and only suited for those who, by the previous study of elementary treatises, have prepared themselves for enlarged and philosophical views of the subject.

The rapid strides which geological science has made within the last few years, the inestimable value of the vast mass of well authenticated facts which has resulted from the labours of its cultivators, and the harmony and consistency with which they now admit of being generalized together, so as to form, if not a complete history of the revolutions of our planet, at least a valuable and authentic outline of a large portion of these changes—a record which future researches may somewhat modify, may greatly extend and perfect, but which they can never subvert or falsify—these truths, though long familiar, were never so strongly impressed upon our mind as on rising from the perusal of the treatise under consideration.

If we look back to a period of only fifteen or twenty years ago, how different was the state of this department of knowledge, how crude and unsettled were many of its first and most important principles, and how hopeless its present comparatively perfect state must have appeared, at least within the short space of time which has since elapsed. Things now rendered self-evident, the very axioms of the science were then matters of dispute, and even those geologists who had devoted a large portion of their lives to the examination of geological phenomena, with their minds stored with the most valuable facts, the result of their own observation, were so completely at fault from the want of established first principles, that, strange to say, they seem in some cases to have shrunk from the task of generalization, and even to have amused themselves by throwing indiscriminate doubt and difficulty upon the phenomena which had engaged their attention—rather marshalling them in contradictory array, than by seeking points of agreement and resemblance, endeavouring to explain the more obscure branches of the subject.

The powerful minds which have laboured so zealously and so successfully in this department of science, have indeed reared a noble and enduring monument, and in a space of time which, from all previous experience, would have seemed utterly inadequate for labours so gigantic. The clue to the ancient and more mysterious workings of Nature—a clear perception of her present operations, from the most minute to the most tremendous and extensive—this clue, so imperfectly possessed a few years since, has now been furnished in a manner at once complete and satisfactory, by the masterly researches of LYELL, and other geologists. The aid of other sciences in their present improved state, has been rendered largely available—Chemistry, Botany, and Zoology, have each contributed rich stores of information to the geologist, giving a degree of precision, before unattainable, to his views, and enabling him to approach questions, the solution of which was previously almost hopeless.

As regards many of the most difficult and obscure problems of Geology, more especially those inquiries into the physical properties of the interior of our planet, to which direct observation can afford but little assistance, a new and invaluable auxiliary has been called to the aid of the Geologist—mathematical science, after soaring into the remotest regions of space, and achieving there some of the proudest triumphs of the human intellect, has at length been directed, and by no means without success, to the internal properties of the globe, the consideration of its ancient relations with the centre of our system, and the mechanical laws which have regulated the fractures of its fissured crust.

By the invaluable aid of exact science, many important results have been already obtained, and others will doubtless follow. It is, perhaps, the highest achievement of Geological science, to connect results of so precise and enduring a nature, with the rude and perplexed phenomena with which it has to deal, and to bring the phenomena of the globe within the compass of the fixed and eternal laws disclosed by mathematical and astronomical investigation. With these views, we look upon the appointment of Professor WHEWELL to the chair of the Geological Society, at its last anniversary, as forming a most important era, and marking an advance of knowledge which will ever be memorable in the history of the science.

Researches of a similar nature to those here alluded to, are now in progress on the continent, but we may enumerate with satisfaction the names of countrymen who are at present thus engaged, and who will doubtless maintain the reputation of our country, in this new and most interesting department of science, which is sufficiently ample to afford new triumphs even to the genius of HERSCHEL and of WHEWELL.

Professor PHILLIPS observes in his preface, that his object in this treatise "has not been to collect together the enormous mass of observed facts which now constitute the wide foundation of geological truths, but to exemplify the most important of these truths, by discussing the phenomena in a certain order, under the guidance of admitted general principles." Such being the plan of the work, we shall now proceed to follow it in detail, and to extract such portions as are best calculated to show the mode in which it is executed. As regards that important consideration in geological science—"*what is possible to be known*"—we have the following admirable remarks:—

"All human knowledge is limited; but who has reached the boundary in any direction? Doubtless there are geological problems which can never be solved, many recondite laws which can never be disclosed by investigation of visible phenomena; but yet the progress of the human mind, or rather the combination and mutual irradiation of ascertained truths, continually removes farther and farther the visible barrier of knowledge, and renders possible many problems once despaired of.

"The province of direct *geological* observation is limited to a small depth below the surface of the globe, and nothing but the progress of a higher science could give us any information as to the interior. But even those dark and unapproachable regions are not wholly hidden from the astronomer; some material properties of the central regions of our planet are already revealed by refined mathematical interpretation of the phenomena of the universe; and though we may never know *what* are the chemical qualities of the substances more than a few miles below the surface of the earth—never be able, in ordinary language, to say *what sort* of matter composes the interior, yet many of its most important properties, as weight, density, temperature, may be at least partially ascertained, and their state of rest or motion, fluidity or solidity, made the subject of probable inference."

After well observing, while treating of general data, that it is to "astronomy and general physics that we are indebted for the establishment of certain leading principles which must ever be observed in reasoning on the revolutions of the globe, and, in fact, form the only general basis for such reasoning," the figure of the earth is thus discussed:—

"The figure of the earth is known by direct measurement of arcs, and by experiments with the pendulum, to be a spheroid with its polar diameter about $\frac{1}{310}$ shorter than the equatorial; the former being 7899,170 miles, the latter 7925,648 miles; the difference, commonly called *the compression*, 26,478 (Herschel—*Astronomy*). This peculiar figure is a consequence of the centrifugal force of the superficial parts of the globe removed from the poles; for this diminishes the influence of gravitation, and permits the equatorial parts, where the velocity of rotation is greatest, to recede further from the axis than any other parts, till the equilibrium is obtained, and the curves over all parts of the globe correspond to a *spheroid of revolution*. The earth, then, has acquired its present figure under the joint influence of gravitation to its present centre, and rotation on its present axis; but if the mass of the globe were solid, this exact accommodation of dimensions could not take place; we must therefore add a third condition, viz. that, in some way or other, its parts must be yielding and displaceable, fluid or loose. If the globe was formerly, or is now fluid within, wholly or in great measure, the spheroidal figure is a direct and necessary consequence, and this is the view generally adopted; but it has been imagined that even a solid globe whose superficial parts were displaceable, might, in the eternal round of natural changes, be worn down by rains and waves from a perfect sphere, to a spheroid of revolution. According to this supposition the former state of the globe was very different from the present; the rotating sphere must have become very elevated land at the poles, and totally drowned in water along an equatorial band; into this equatorial sea, from the north and the south, must have been poured the waste of the high polar lands so as to form strata thickest under the equator; the slope should still be land:—but nothing of the kind appears. On the contrary, the distribution of land and water is excessively irregular, the surfaces of stratified rocks have no peculiar relation to the equator, the poles are in the midst of water, and the equatorial regions include some of the highest mountains on the globe. This hypothesis is therefore entirely gratuitous, and we must look to the interior of the earth for the displacement of substance which allowed it to assume a spheroidal figure.

"Here little difficulty presents itself; it cannot be doubted that, if the interior of the globe were fluid, a spheroidal external figure must necessarily result from rotation on an axis, and the internal surfaces of equal density be also spheroidal; and both these conditions be retained whether it continued fluid or not; if it continued wholly fluid, the figure might continually adapt itself to any change of form corresponding to a variation of the ratio of central and tangential forces; if it became wholly solid, the rocks would upon such change of ratio be put in a state of strain; if internally fluid and externally solid, the crust might upon such change yield in various directions, and produce local irregularity in the distribution of land and water: finally, if the solidification of the surface were to proceed at a certain rate, compared with that of the change of ratio of the forces governing the figure, the form once acquired might be almost invariably preserved.

"Of all the conditions stated above, which corresponds best to what is known concerning the earth? That its internal surfaces of equal density, are situated symmetrically with respect to the external spheroid is supposed to be true, in consequence of investigations concerning certain irregularities of the moon's motions, which depend on the figure and density of the earth. This would prove that the earth has been freely yielding within; the irregularities of the pendulum experiments appear sufficient to justify a belief that the solidification of the surface has gone to some considerable depth; the irregular distribution of the land and water appears to indicate the co-existence of a solid crust and yielding interior, accompanied by a change of form. This irregularity of land and water is the effect of great convulsions of the crust of the globe belonging to many geological periods, some of them subsequent to the existence of the present races of animals and plants. It is therefore very probable that the interior of the globe has formerly been wholly fluid; and we are not entitled hastily to reject the supposition that it is partially so at this moment."

The density of the earth is next considered—after stating, that taking water at a temperature of 60° Fahr. as the unit of comparison, the superficial portion of the globe, judging by the weight of the most abundant rocks, must have a specific gravity of about 2.5, while the mean density of the interior has, from various experiments on the local attraction of mountains, been estimated at about five times greater than that of water, we have the following concluding observations:—

"From the influence of the earth on the moon's motions, it is inferred that the internal mass of our planet augments in density towards the centre; the surfaces of equal density being symmetrical with the external spheroidal surface. The materials of the earth have therefore collected round the centre in obedience to the laws of gravitation and rotatory movement, and the internal substances, as having fallen to the lower place when freedom of motion was allowed, would probably be heavier under the same circumstances than the superficial substances. In their present situation, their weight is augmented by the effects of the general pressure towards the centre; if the laws of compression observed among metals, stone, fluids, and gases, at the surface of the earth, obtained in the inner parts of the earth, without some counteracting cause, steel would be compressed into one-fourth, and stone into one-eighth of its bulk at the centre. Water, according to Leslie, would be as heavy as quicksilver at 362 miles depth, and air as heavy as water at thirty-four miles. (Somerville—*Connexion of Physical Science.*) Now, though we cannot presume that the law of compression would hold in these bodies to such an extent, enough is known to justify a confident belief that the mean density of our planet would be very much greater than it is, were not the tendency to enormous condensation in the central masses counteracted by some powerful agent of expansion, such as heat, or neutralised by some peculiar and unknown constitution of the substances themselves."

The temperature of the globe is then treated on, "no proposition being more certain than the fundamental dependence of the temperature of the surface of the globe on the solar influence," while the inadequacy of the eccentricity of the earth's orbit (within any limits which are at all probable) to account for the former high temperature of the globe, is pointed out—when we have the following remarks on the nature of the surface, as connected with temperature:—

"The heating effect of the sun's rays varies with the nature of the surface on which they fall: the colour, texture, capacity for heat, and other circumstances affecting the absorbent and reflective powers of the substances, influence, accordingly, the amount of heat absorbed and retained. The reflective surfaces of snow which cover so large a portion of the polar land, while they refuse admission to the solar heat, and contribute to warm the upper air, prevent also the dissipation of terrestrial warmth. Sandy and rocky tracts reverberate heat into the air; grassy plains and cultivated fields freely absorb heat by day, and freely radiate it by night."

The distribution of land and water, and the equalizing influence of the ocean upon the earth's temperature, are then noticed, and the former of these elements, considered, as we believe very justly, incapable of having produced any very sensible difference, in ancient geological periods, or of influencing the temperature of the globe more than a few degrees. Temperature, as dependent on elevation, is thus noticed—

"Elevation above the mean level of the sea, is another important circumstance affecting local climate, and the general amount of heat on the earth and in the air about it. The atmosphere surrounding the earth is not heated by the sun's rays passing through it; it freely transmits them. Clouds, and particles of all kinds in it, must arrest some heat as it radiates from the sun or from the earth, but the main supply is derived from the earth by conduction. Near the earth, the temperature of the air seldom differs from that of the surface, whether that be land or sea; and in all the higher regions, amidst the complication of aërial currents which rather alternate than mingle, we find the temperatures decrease as the density of the air diminishes, so that, at moderate heights, a diminution of 1° Fahrenheit corresponds to about 323 feet elevation. (Forbes).

"This settled law of atmospheric heat reacts on the elevated land, and causes a reduction of the mean temperature of the higher stations, exactly of the same nature, and as regularly calculable, as that depending on latitude."

Professor PHILLIPS then proceeds to consider the temperature of the planetary system, or rather the space in which the planets revolve:—

"The temperature of the space surrounding the earth cannot be hotter than the coldest point on the surface of the globe: for, since the globe is continually receiving heat from the sun, and radiating it into space, the cooling process can only proceed so far as to reduce the surface temperature to an equilibrium with that of surrounding space.

"The lowest temperature on the globe (Melville Island) being taken at 50° cent. below zero,* we may be sure that the ethereal spaces have not a higher temperature. In fact, Fourier and Swanberg agree in adopting this as the real temperature of the planetary spaces. The opinion, daily gaining strength, of the universal diffusion of an elastic ether, renders probable the conclusion that the immense regions in which the planets move have a definite temperature; if the ether vary in density about different centres or systems, which is at least not improbable, the statical temperatures may vary also with situation; but, as far as we have yet learned of the solar system, there is no reason to imagine the temperature is sensibly variable with time; not even if the planets are continually losing heat."

The important and long-contested point, the interior temperature of the globe, is next discussed; the author observes—

"Hitherto we have considered the globe as merely a recipient of heat from the sun, measured in quantity, and distributed in a particular manner. This heat is again partly dissipated into the atmosphere and ethereal spaces, so that there is no superficial accumulation of heat derived from the sun: the climates on the earth appear to be constant, except by the interference of some of the variable circumstances previously adverted to.

"But we must not bind our views to the surface; the state of the interior of our planet, in relation to the intensity, constancy, and circulation of the heat there, is of the greatest possible importance.

* * * * * *

"It appears from the mathematical theory, and it is fully established by experiment, that the fluctuations of the solar heat are experienced only to a certain depth, below which the temperature of any one point is invariable; this depth is not every where the same, but, as far as yet appears, nowhere exceeds 100 feet. The temperature at this depth is constant, and generally corresponds, at least nearly, to the mean annual temperature of the surface. The temperatures below this depth can only be known by experiment. Before stating the results of these, it may be useful to advert to the simple reasoning which must be employed in drawing conclusions from them. If it be found that the temperatures below the zone of fluctuating heat continually diminish, it is evident that the interior parts of the earth are colder than the surface, and that there is no reason to imagine the earth to have any other source of heat than solar radiation; but if the contrary be found true, the earth has a proper temperature, derived from internal sources. If the augmentation be merely a *local* phenomenon, *local* chemical action may perhaps explain it, but if it be a *general* fact, we must appeal to a corresponding general cause.

"Experiments on the temperature of the interior of the globe require great attention, and must be interpreted with caution. In mines, collieries, &c., the influence of lights, respiration, &c., is considerable; in these, and almost all situations, chemical processes go on which must be considered; there are local sources of heat to be allowed for, as mineral waters, the augmented density of air, &c. Into the examination of these points it is not necessary to enter further. The reader must suppose that they have been attended to by M. Cordier, M. Arago, and others, both in selecting experiments and drawing inferences. The following examples include single and continued observations in different situations and under varied circumstances.

"Single experiment in the deepest colliery in Great Britain at Monkwearmouth, near Sunderland, soon after the sinking of the shaft (Phil. Mag. 1834). Depth of the pit to the place of observation, 528 yards; depth below the level of the sea, 500 yards; mean annual temperature, 47.6. Observed temperature of air at surface on the day of experiment (15th November 1834), 49°—of air at the bottom of the pit, 62°—near the forehead (or end of the drift), 64°—close to the coal, 68°. Temperature of water collected in the pit bottom, 67°—of salt water issuing from a bore hole made on the same morning, 70.1—of similar water as it first gushed out, 71.4—of gas bubbles issuing through the water, 72°6. Temperature of the front of the coal, 68°—of the interior, 71°.4. A thermometer left in a bore-hole for a week, indicated 71°.2.

"If invariable temperature be supposed to commence at 100 feet, and the mean annual temperature of the place be taken at 47.6, then 72.6—47.6=25° in 1484 feet, or 1° F. in twenty yards English, nearly. The pit has since been sunk deeper, and the temperature is found to have risen still higher."

Detailed experiments on the temperature of the interior of the globe, as proved by the influx of water, having a high temperature, in deep mines, by continued experiments in rock, and by Artesian wells, are then given, the results being, that "*without a single exception*, the interior of the globe is warmer than the surface, the heat augmenting constantly with the depth." As regards the

* Equivalent to 58° below zero, Fahrenheit.

mean rate of augmentation, it is stated at "one degree of Fahrenheit in forty-five feet English." Thus strong support is given to the hypothesis, that earth is a cooled, or rather a cooling, globe, which still retains its original high temperature in the internal portion of mass.

We extract the following conclusions on the depth of the ocean:—

"If we were to suppose the depths of the sea proportioned to the heights of the land, in the ratio of the respective areas, and similar inequalities of level to prevail, the greatest depths might be taken at about fifteen miles, and the mean depth would not exceed from one to five miles, according to the supposed form of the oceanic bed.

* * * * * *

"According to this view, the depth of the sea on the east coast of England is 120 feet, on that of Scotland 360 feet, of the Atlantic coast of Ireland 2600 feet, of the Atlantic (in its middle part) 50,000 feet, or above nine miles. These depths, judging from the soundings on the east coast of England, are good approximations."

Treating of the extent of the atmosphere, it is observed, that "in every case of well-conducted analysis, the atmosphere has every where and always been found similarly constituted," but it is shown that even this does not necessarily prove its statical condition, which is rendered doubtful by various circumstances, more especially the existence of so vast a quantity of oxygen as is fixed (whether with absolute permanence we cannot decide) in the composition of the most prevailing rocks, often amounting to half their weight.

The materials of the globe are next considered—

"Rocks or very considerable component masses of the globe, are composed of particular mineral substances, which are resolved by chemical analysis into their proximate constituent parts, these being further resolvable, in many instances, into elementary or undecomposable molecules."

On the condensation of oxygen before noticed, we have the following remarks:—

"In the present temperature and pressure of the atmosphere, oxygen can only exist separately as an expanded gas, about $\frac{1}{880}$ part of the weight of water; but in the solids and liquids of the crust of the globe it is condensed to an astonishing degree. In water, it is joined with the light gas hydrogen, condensed 2000 times, and in the same or a greater proportion in the oxides of metals."

The importance of mineralogy to the geologist is thus noticed—we conceive the remarks to be extremely just, and at the present period peculiarly applicable:—

"The geologist is not absolutely required, except for particular trains of reasoning, to be an accomplished mineralogist; but it seems unwise to countenance the neglect of mineralogy, which appears to have become not unusual among those who have been foremost to cultivate the zoological principles of geology. We must not grant to the lovers of organic remains that a person may be too good a mineralogist to be a good geologist."

In the following observations, we are pleased to find that Professor PHILLIPS gives the practical miner his due, as regards the local knowledge which, independently of science, he has ever been found to possess:—

"It cannot with truth be said that the arrangement of materials in the crust of the globe has ever been entirely unknown, because the operations of mining, however ignorantly begun and conducted, must infallibly have led to correct, though very limited, information concerning it. No considerable mining region in the civilized world has ever been visited by geologists where the structure of the metalliferous mountains has not long been partially known. What geologist has been able to add to the knowledge of this kind possessed by the old miners of Aldstone Moor? In what coal district have the workmen been found wholly ignorant of the succession of the sandstones, shales, and coal in which their operations are conducted."

The mineral structure of Great Britain is well explained, and illustrated by a tabular view of our stratified rocks, the strata of other countries are then noticed, concluding with the following observations:—

"Few parts of the globe except some of its vast plains and deserts are entirely deficient of rocks which are not stratified, though the surface which they occupy is not nearly as great as that covered by the strata. Granitic and basaltic rocks compose generally the greater portion of the unstratified masses, as in Britain, and lie in the same relations to the strata. For granitic rocks, throughout the globe, are the most frequent axes or centres of mountain groups, and basaltic rocks fill dykes and spread in irregular cappings over the strata. It is evident, therefore, that the structure of the exterior parts of the globe, though full of local diversity, is all formed upon one general plan, and produced by similar agencies."

On the general constitution of the class of stratified rocks, we extract the following summary:—

"Viewed generally, the most abundant stratified rocks may be referred, according to their chemical constitution, to one of three great groups, viz., Silicious rocks, Silicio-aluminous rocks, Calcareous rocks.

"The secondary and tertiary series of strata consist principally of alternating strata of these qualities, and the same is less obviously true of the primary strata. If we consider in what mineralogical characters this general result depends, we find the silicious rocks have almost universally a preponderance of the mineral quartz; the silicio-argillaceous rocks consist of quartz with distinct or indistinct admixtures of felspar, mica, chlorite, or other minerals containing alumina. Distinct mixtures of these minerals occur both in the primary and later classes of strata, but there is a great difference in the appearances of the compounds. Gneiss, mica-schist, &c., in the primary series, have very much the air of crystalline aggregation; the secondary and tertiary sandstones are clearly mechanical aggregates; yet upon more close scrutiny, this difference diminishes or vanishes. Several sandstones are almost crystalline, the particles of gneiss are really fragmentary; in both the parts are truly crystallised as to the interior texture, but in neither of them entirely free from the effects of some mechanical movement. The mica of gneiss is not often perfectly hexagonal as in granite, the quartz has generally lost its exact prismatic shape, the felspar its prominent angles. Exceptions to this occur certainly, but it is quite true as a general rule, and when fully investigated leads to a positive conclusion that nearly all the non-calcareous primary and secondary strata have been subjected, but in very different degrees, to mechanical agencies, like those concerned in the accumulation of common sandstone. Now the least examination of sandstone rocks, and comparison of them with the sandy and argillaceous deposits from rivers, in lakes, and on the borders of the sea, leaves no doubt that they have experienced the agitation of water; in fact, that they were sedimentary deposits.

"Some limestones do and others do not yield evidence of similar agitation; they are often to be considered as aggregations of particles of carbonate of lime, slowly collected from chemical precipitation in water."

We have now extracted largely from the enunciation of elementary facts, which forms the first part of the volume, and shall, therefore, glance but briefly at the remainder, which is devoted to a brief review of the facts of descriptive geology. On the stratification of the primary rocks, influenced as it often is by "subsequent change of structure, by molecular aggregation under the influence of heat, or other general agency," Professor PHILLIPS remarks—

"Another very general cause of difficulty in determining the stratification of primary rocks arises from the changes of structure introduced among them since their deposition. The contraction of these, as well as of other rocks, has occasioned the production of a multitude of divisional planes or joints variously related to the surfaces of stratification, and often, especially in the finer grained and laminated rocks, assuming an admirable symmetry of direction and inclination. Thus tabular and other regular structures appear in the stratified primary rocks, which arrest the attention, and add a new cause of embarrassment."

Treating of the clay-slate system, which presents such remarkable instances of the symmetrical jointed structure, we have the following observations:—

"This structure is very evident in some parts of the clay-slate system, but very indistinct in others. Thus in Cumberland it would be a difficult thing to say what were the planes of stratification in the Skiddaw slates, but for the assistance of the chiastolite slates beneath, and the red argillaceous rocks of Derwentwater above. The planes of stratification thus judged of appear to rise to the north-west toward an axis passing from Caldbeck Fells south-west to Egremont. The same direction and dip of strata is to be inferred from the interposed limestone beds of Coniston Water Head (Bala limestone), and it is confirmed by minute examination of the alternation and gradation, of the different sorts of slate.

"But, certainly, on a general view of the country, the stratified structure is far from evident; so that many persons, impressed by the remarkable structure called cleavage, which traverses nearly in vertical planes the surfaces of stratification, and the symmetrical joints which divide the rock into prismatic masses almost of geometrical regularity, leave the district under the impression that it was not at all stratified.

"The same remarks apply to the slaty tracts of Cornwall and Wales, in which, especially the latter, both cleavage planes and symmetrical joints predominate over the stratification. That these structures are of later date than the stratified structure, is evident when we compare primary and secondary districts, for in the latter symmetrical joints pass through imbedded organic remains, and through many alternating sedimentary strata.

"They are in fact superposed structures, and from what is known of the introduction of similar structures into ordinary clays and shales by the side and in the vicinity of igneous rocks, independent of general considerations, such as the high degree of induration of these rocks, there is little doubt that the agency of heat is the general cause of these phenomena of structure. Argillaceous slaty rocks deposited from water like common clays and shales, still retain traces of their original stratification, but they have undergone generally those changes depending on pervading heat, which later secondary rocks of similar original nature have experienced locally near the granitic region of the Col de Balme, near the Whin-Sill of Teesdale, and the whin-dyke of Coley Hill."

On the gradation which is apparent between the primary and secondary strata, we extract the following:—

"That system is so linked with the mica-slate and gneiss, that the whole mass of primary strata may be conceived to be the result of physical conditions, gradually or periodically variable, but not suddenly interrupted. It appears that, in the deposition of the subcrystalline gneiss and mica-slate rocks, mechanical agitation of the ocean was rare and slight; and that, on the contrary, in the highest group of the primary strata, the sandstones and conglomerates indicate frequent and considerable watery disturbance.

"Nearly in the same ratio, the monuments of organic life appear and grow numerous, the limestone bands become more regular and continuous, the stratification less complicated by superimposed structures, and the characters of secondary strata appear."

From the notice of the carboniferous system, we extract the following description of the upper portion of the series, commonly known as "the coal measures:"—

"The coal measures are 3000 feet thick in the north of England, consisting of abundance of sandstone and shales, layers of ironstone, and beds of coal. Of these are many alternations, constituting a series of many nearly similar terms, usually containing at least the three substances—coal, sandstone, and shale. Scarcely any limestone occurs in this upper coal-measure series. One bed is, however, found in the Yorkshire coal-field, containing marine shells, while in all the rest of the strata nothing but fresh-water and terrestrial exuviæ occur. A limestone bed with estuary shells is found in Shropshire, and near Manchester.

"The coal seams, twenty or thirty in number, amount in all to a thickness of about sixty feet, in a mass of shales and sandstones at least 3000 feet. Nearly the same thickness of coal occurs in the coal-fields of Newcastle, South Wales, &c., though the earthy substances enclosing the vegetable products vary in nature and thickness. The thickest coal seams in Staffordshire and Ayrshire, ten or fifteen yards, are in fact composed of many beds of different qualities aggregated together. The quality of coal is partly dependent on the plants of which it was originally composed, and partly on subsequent changes produced by subterranean movements, effects of heat, &c. The principal differences arise from the variable quantity of gaseous matter. In the stone coal (blind coal or culm) of South Wales, Kilkenny, and Virginia, which burns like coke, there is little or nothing but carbon and earthy admixtures. The box or cannel coal of Lancashire and Yorkshire, which blazes like a candle, contains nearly half of its weight of gaseous matter. There is but little coal, and that in the lower part of the series, in Ireland.

"The ironstones of a coal district lie generally in layers of nodules, each frequently enclosing a leaf or shell, or some other nucleus of molecular attraction.

"The shales are bituminous or sandy; the sandstones laminated or massive, micaceous, argillaceous, subcalcareous, or felspathic, very rarely of a red colour, though blue, yellow, brown, white, and other tints prevail. Chalybeate springs are general, and salt springs not uncommon in the northern coal tracts."

The magnitude of the disturbances in the carboniferous system are well calculated to excite surprise in those who are not conversant with geological phenomena:—

"The Penine disruptions, ranked by De Beaumont under the title of the System of the North of England, are on a magnificent scale. Three principal lines compose this great system—the northern branch ranges along Tynedale from Brampton to the sea fifty miles, bending more than once from its average recticlinal course to the east by north; the southern branch passes in a straight line to the east-south-east thirty miles, and the two are connected by a line of fault, whose mean direction is nearly north and south, but it has three several courses in a length of fifty miles. The Craven, or southern branch of the system, is a double fault; the Penine line is partly an anticlinal and partly a fault; the Tynedale branch is one great fault. With reference to a point in the middle of the area, enclosed by these dislocations, their effect is everywhere similar, viz., a mighty depression of all the exterior country. North of the Tynedale fault is a depression or throw of 1000 to 2000 feet; west of the Penine fault, 2000 or 3000, or perhaps 4000 feet under Crossfell; and south of the Craven fault 3000 feet at least under Ingleborough."

Treating on the colitic series, the author well observes, after noticing the characteristic fossils which mark the subdivisions of this system, that on "comparing distant regions, only the broader zoological features of the rocks can be employed with safety." On the peculiar structure which distinguishes the oolitic limestones, we have the following remarks:—

"The concretionary structure of these limestones is imitated in modern times only in situations where carbonate of lime is separated from chemical solution in water (Carlsbad). If we ascribe this origin to the oolitic sediment, the concretionary aggregation of the particles may be understood as arising from molecular attraction in the mass, and; in fact, many of the spherules of oolite contain an internal nucleus of previously solidified matter, a small shell, a grain of sand, or somewhat else, capable of determining the condensation of the particles to particular centres, just as the matter of ironstone has collected into nodules round a fish-scale, a piece of fern branch, or a shell."

Describing the tertiary strata, the author well observes—"they admit of a clear comparison, in all respects, with the effects which daily occur before our eyes, and thus facilitate our inquiry into the condition of Nature in earlier periods"—and he further points out, as characteristic of this era, "the deposition of stratified rocks in limited basins of fresh water."

Passing over the relation of the tertiary to historical periods, superficial aqueous deposits, detrital and lacustrine deposits, we come to the subject of volcanoes. Professor PHILLIPS infers, "that each volcanic vent has a definite date of origin—lives through a period of activity, and decays by gradual or intermitting stages, till nothing is left but the marks of what has been." We extract the following:—

"At the base of a volcanic vent, deep in the earth or under the sea, particular mineral aggregates, slowly cooled, under great pressure, and in great masses, may, and probably do, at this day assume the largely crystalline texture and distinctness of ingredients of granite; on the bed of the sea they may flow in the state of porphyry or basalt; on the surface of the land appear as porous lava, and be blown into the air in disintegrated scoriæ, ashes, and dust."

The gaseous products of volcanic action are ascertained to be "chlorine, sulphuretted hydrogen, sulphuric acid, carbonic acid, nitrogen (Daubeny). Sir H. Davy found the sublimations of Vesuvius to be chloride of sodium, chloride of iron, sulphate of soda, chloride of potassium, sulphate of potash, oxide of copper, chloride of cobalt."

Volcanic products (little else than mixtures of felspar and augite) are next considered, together with the phenomena of extinct volcanoes—the connexion of earthquakes and volcanoes—hypotheses of volcanic action, and several other complex geological problems. Our concluding extract will be, however, from the short notice devoted to the subject of mineral veins. Treating of the prevalence of mineral veins in rocks of different ages, the author observes—

"As a general result, we cannot doubt of the far greater prevalence of mineral veins in the older than in the newer rocks. Not one case is known of a mineral vein being at any time worked in any part of the British islands above the new red sandstone. In the new red sandstone and magnesian limestone hardly more than slight traces of such products occur; they are rare in our coal tracts, but they become abundant in the mountain limestone and older strata. But yet it is probable that this relation of mineral veins to the age of deposits is merely a consequence of the more general truth, that their origin is from below, that the fissures which they occupy, and the metallic and sparry matters which compose them, are more numerous near the igneous rocks which in so many instances form the axes of movement. It is not merely because of the antiquity of the killas of Cornwall, but of its proximity to granite rocks, that it is so very metalliferous; the limestone of Ireland, undisturbed by great axes of movement, is very little metalliferous; while the same rocks dislocated in Mendip, Flintshire, Derbyshire, &c., yield many sorts of metals and spars, in veins of different kinds.

"Thus, the most general point of view in which mineral veins present themselves, is that of dependence on proximity to the sources of subterranean heat. In the rocks nearest these sources they are most numerous and varied; they abound near the disturbances which are consequences of variation of internal heat; and, in certain cases (Pyrenees, &c.), they are not rare even among newer strata where the subterranean igneous rocks have exerted a remarkable influence."

We do not observe any notice of the *dissemination of metals in rocks*, a phenomenon which, if duly considered, would, we presume, somewhat modify the theoretical views brought forward with regard to the repletion of mineral veins.

The copious extracts we have now given, and the remarks by which they have been accompanied, leave but little room for further observation. We have before observed that the work cannot by any means be considered as elementary, and it is therefore only suited to those who have previously studied more familiar treatises on the subject, and to one or two of the best of these we have in our earlier Numbers directed attention. To readers who are thus prepared for the higher truths and generalizations of geological science, we strongly recommend Professor PHILLIPS's admirable work, and doubt not that they will derive equal benefit and pleasure from its perusal.

The Grand Junction Railway Companion to Liverpool, Manchester, and Birmingham; and Liverpool, Manchester, and Birmingham Guide. By ARTHUR FREELING. Henry Lacey, Liverpool. Charles Tilt, London. 1837.

There are few requisites more indispensable to the intelligent traveller than a topographical description and good map of the country through which he passes. With these in his hand the journey becomes doubly interesting—scenes which possess aught to claim his attention, are noticed and appreciated as they pass in quick review before him—and confused imperfect recollections are connected into a valuable and satisfactory retrospect.

These remarks, although of general application, apply most forcibly, however, to railway travelling—in this case the scenes are truly evanescent—the traveller is hurried on with the rapidity of lightning, and scarcely possesses the power to look behind him, or to catch a second glance at an object which may have caught his attention. The beauties of Nature, and the triumphs of art pass in quick succession before the sight—the populous town—the stately spire or mouldering ruin—the picturesque river—the bold bridge—the massive viaduct—the deep excavation or lofty embankment—each are seen but for a moment, sufficient to excite, but not to gratify the curiosity.

It is evident that these circumstances must speedily call into existence a new class of topographical and descriptive works, and to this class it is that the pleasing and well-arranged little pocket volume before us belongs. It commences with a short historical account of the Grand Junction Railway, and then furnishes ample information, as regards fares, distances, time of starting, and other railway regulations, of importance to the traveller. The body of the work is occupied by a "Guide," pointing out in a very convenient form the various objects of interest on the line—both those connected with the adjacent towns and villages, and with railway itself. The conclusion of the volume forms a Guide to the great towns communicating with the railway—Liverpool, Manchester, and Birmingham.

From the introductory portion, we shall extract the following short history of the Grand Junction Railway:—

"It will not be considered necessary to go into any detail of the history or progress of the line, from Liverpool to Manchester and Warrington, as separate works have long since made the public acquainted with everything interesting regarding it. A slight sketch of the various applications to Parliament for power to complete the Grand Junction portion of the line will, however, not be uninteresting, especially as it exhibits the difficulties which invariably attend the promotion of a public good, when opposed to private interest. It is too often to be regretted, that the chief opposition to the efforts of those public-spirited individuals who originate such works, arises from persons whose real interests are not affected, but whose temper or caprice raise up a host of evils which exist only in their perverted imaginations.

"Men who propose and carry through, without regard to evil or to good reports, such works as the Grand Junction Railway—who have overcome not only the opposition which the stupendous operations of nature present, but the more stubborn and unbending resistance of haughty and interested minds—are far more worthy of the laurel crown than the victor of a hundred fights. The one confers on his country honour and prosperity—crime, devastation, woe, wailing, and death attend the career of the other; which, at the best, ends in the attainment of but equivocal benefits.

"In 1823 the project of the Liverpool and Manchester Railroad suggested to some gentlemen in Birmingham the idea of a railroad to connect Lancashire and the north with the south of England. To effect this object, Mr. R. Spooner, Mr. Sparrow, and Mr. Foster came over to Liverpool, and, when there, arranged a committee of Liverpool and Birmingham gentlemen to carry forward the project; and in 1824 an application was made to Parliament for permission to make a railroad from the Cheshire side of the Mersey, opposite Liverpool, to Birmingham.

"This bill was most violently opposed by the canal and landed interest, and was lost on Standing Orders in the House of Commons. In 1826 another application was made, which shared the same fate.

"It would appear that, disheartened by the opposition encountered, the committee relinquished the prosecution of their first project; and all public operations, with a view to effect this national work, lay in abeyance until just before the opening of the Liverpool and Manchester line in 1830. Meetings were then held in Liverpool and Birmingham, and another line proposed.

"It was now arranged that the Liverpool committee should apply for a line from Liverpool to Chorlton, in Cheshire, and the Birmingham committee for a line from Birmingham to Chorlton. It is not necessary to insert the particulars of the prospectus then issued; suffice it to say, that, after a most

violent opposition, the bill from Birmingham to Chorlton was ultimately lost.

"The bill from Liverpool to Chorlton was but a little more fortunate, for, having passed its first stages, it was lost by the dissolution of Parliament on the Reform question. The great opposition which the committee had to encounter, in their progress with this bill, was made by the Mersey and Sankey Canal Companies, on the ground that the bridge which it was proposed to erect across the Mersey would impede the navigation of the river: and when we consider the number of persons connected with these companies, the extensive ramifications of their connexions, in addition to the ground of opposition being one purely of theory, and, therefore, more open to debate, we may form some idea of the difficulties the committee had to contend with. As this opposition was, however, overcome—as it must be frivolous, though vexatious—we trust that it will not be repeated when a project of which we have yet to speak comes before Parliament.

"In 1831 preparations for applying to Parliament were again made; but the fate of previous attempts, and the opposition threatened, caused the committee and subscribers to defer further proceedings that year.

"In 1832 a meeting was held in Liverpool, John Moss, Esq., in the chair, when it was determined that one bill only, and that from Birmingham to Warrington, from which place there was a railroad to Liverpool and Manchester, should be applied for; that the shareholders in the two concerns should be invited to unite in one, and the management be transferred to Liverpool. This was ultimately done, and Mr. Rastrick was appointed engineer for the Birmingham, and Mr. Stephenson for the Liverpool end of the proposed line; and a bill to effect this project was, after some short time, prepared for Parliament.

"The whole management of the concern had, however, fallen into the hands of Liverpool gentlemen, who had had experience in the Liverpool and Manchester railroad, both in obtaining the Acts of Parliament, and making a railroad. To the experience of these gentlemen in the latter object are the subscribers indebted for the extraordinary fact, that the 82½ miles of their line (which is accomplished with a degree of solidity and finish at present unrivalled) have cost them but about 1,500,000*l.*, while the works on the Liverpool line, which is but thirty-one miles, have cost two-thirds, or perhaps more, of the same amount; an expenditure, be it recollected, not recklessly or carelessly incurred, but one which was necessary to obtain the experience and information which will now enable others to execute similar works at so great a reduction of cost. Every railroad company which may in future exist is infinitely indebted to the Liverpool and Manchester Company; and if the feelings and principles which regulate the actions of individuals towards each other, when their own affairs alone are concerned, could be brought to bear upon their operations when incorporated in public bodies, committees, boards, &c., the proprietors of every railroad would contribute handsomely to a compensation fund, to repay some of the enormous expense incurred, in their experimental outlay, by the shareholders of the Liverpool and Manchester Railroad; for, as their intelligent and talented secretary observes, in his able pamphlet, 'In matters of detail, no less than in the grand outline and structure of their work, the Liverpool and Manchester Railway Company have found, that on them has devolved the task of making experiments for the rest of the world.'* Alas! I fear this act of justice will never be accomplished. There is no chivalry in 'companies.'

"The anxiety of the gentlemen into whose hands the prosecution of the project had now been consigned, was to conciliate and do away with the opposition of the landed and canal interests; this they were most successful in accomplishing, and that too with a very small sacrifice of money, as compensation for *ideal* and real injury to landed proprietors; and the bill for making the railroad from Birmingham to Warrington obtained the Royal Assent on the 6th May, 1833, after having experienced a phenomenon in the history of railroads, the like of which never has been seen, and, probably, never will be seen again—the bill having passed both Houses of Parliament almost unopposed, without putting the company to the expense of a single fee to counsel. The conducting of the case was left entirely to Mr. Swift, of Liverpool, the solicitor for the bill, who thought it prudent to retain counsel, in case of opposition, but the briefs were never delivered. The directors aided Mr. Swift in the removal of difficulties, by personal applications to all parties who felt themselves injured, or likely to be so; and thus, by tact, prudence, and perseverance, brought the projected bill through Parliament.

In 1834 an amended bill was obtained, to alter the line through Staffordshire, and another to purchase the Warrington and Newton Railroad, which is now, therefore, the property of the Grand Junction Railway Company.

At the commencement of the present year, 1837, notice was given for a bill to alter the line to Liverpool, by forming a railroad from Daresbury, in Cheshire. It is proposed to carry it over the Mersey and Irwell Canal, and to cross the river Mersey at Fiddler's Ferry; from thence to proceed near Penketh Lodge to Rain Hill Stoops, and, leaving the grounds of Halstead a little to the south-west, join the Liverpool and Manchester line at the bottom of the Whiston inclined plane. Thus six miles will be saved, and three inclined planes will be avoided, a most desirable object, for, independent of the time saved, the prodigal waste of steam-power which is caused by these inclines will be unnecessary.

"We have before stated the names of the two eminent engineers who drew the original plan of the railroad, as carried through Parliament in 1833. It devolved, however, on Mr. Locke to carry their plans into operation, and to make such alterations as circumstances suggested as improvements. To this gentleman belongs the honour of completing this stupendous work, within a few days of the time calculated on; and too much credit cannot be conferred on him, and the contractors, for the masterly manner in which it has been accomplished, and the punctuality with which it has been completed. The directors never calculated on opening the line until June, 1837, and on the 4th of July they received the first sum for the carriage of passengers.

"The opening of this national undertaking was unattended by any display. This did not arise from apathy on the part of the public, as the thousands that waited at many of the stations for the arrival of the first trains which passed along the line fully testified; but out of respect to the memory of the late Mr. Huskisson, who met with the fatal accident which caused his death at the opening of the Liverpool and Manchester line. The chairman, John Moss, Esq., and deputy chairman, Charles Lawrence, Esq., having been present at that melancholy event, requested, on this account, that a public opening should be dispensed with; and we are happy in finding that this sensitive propriety of feeling—this respect for the memory of the deceased, was responded to in the breasts of their brother directors.

"On the 3d of July the directors, the secretary, and some of their friends, rode along the whole line, to inspect the works, and returned on the 4th; having discharged their duty to the public, and paid a marked tribute of respect to the great man whose name will ever be so lamentably associated with the history of railroads in this country.

"We have thus traced this great work from its earliest projection unto its completion. In collecting information we have made frequent inquiries, and find that the work has been finished with fewer accidents than usually attend such great undertakings; this must be equally gratifying to the directors and to the public."

The typographical arrangement of the "Guide" itself will hardly admit of extract in our columns; we shall, however, take, as a specimen, the following account of Nantwich, in Cheshire, well known for its brine springs and salt works:—

"Nantwich is a market town and parish in the hundred of the same name county of Chester, situated on each side of the Weaver, in a valley which contains some of the richest dairy land in the kingdom; population, town and parish, 5357, town, 4886; An. As. Val. 6484*l.* Market on Saturday; fairs, March 26, the second Tuesday in June, September 4th, and December 4th, principally for cattle, sheep, pigs, and once a fortnight for horned cattle, from Candlemas to the fair in March. The principal occupation of the inhabitants is the manufacture of salt, shoes, and cotton; it has also a large trade in cheese. Nantwich, it would appear, existed in the time of the Britons, previous to the Roman Invasion, when it was called *Halen Gwyn*, or the White Salt Town. Its present name is undoubtedly from the British word *nant*, a brook or marsh, and the Saxon *vic*, or as commonly pronounced, *wich*, a settlement, usually applied to places in which salt is made; the words combined signifying a salt town in a low or marshy situation. This is the first place in which salt was manufactured in Britain; hence the Romans named it Salinis; it is tolerably certain, however, that they obtained salt from the brine-springs only, as we find no mention of the salt mines until the latter part of the seventeenth century. The inhabitants have the privilege of not serving on juries out of the town, or with strangers; this was confirmed in the reign of Elizabeth, but is of still more ancient date. The church, dedicated to St. Mary and St. Nicholas, is built in the form of a cross, with a semicircular choir, and a fine octagonal tower rising from the centre. This church contains a portion of the remains of Vale Royal Abbey, several of the stalls having been brought from thence at the period of the dissolution. The living is a rectory, in the archdeaconry and diocese of Chester; K. B. 27*l.* 3s. 4; An. Val. P. R. 100*l.* It is endowed with 1900*l.* by private benefaction, the Crown, and a Parliamentary grant; patron, Lord Crew. The town has many charitable institutions. The widow of the immortal Milton resided here several years before her death, and here died in 1726. Nantwich is the only town in the county which, in the civil wars, uniformly adhered to the Parliamentary party. It suffered, however, severely, although it several times repelled the Royalist forces with great slaughter. The town was visited by the plague (1604), which carried off upwards of 500 persons, at that time probably more than half its inhabitants."

We must not omit to mention, that the work is accompanied by a very superior Map of the Railway, to which Mr. Locke, the engineer, has contributed much information. We conclude, by strongly recommending this little volume to the railway traveller, who will find there all the information he can desire, and we may observe, that it appears to form only the first of a series of Guides, on which Mr. Freeling is now engaged, embracing all the great railways in the kingdom.

The Railway Magazine and Annals of Science. No. XXII., for December, 1837. By JOHN HERAPATH, Esq. Wyld, London.

The present Number of the "Railway Magazine" completes the Third Volume of the New Series of that work, for which it contains the Index and Title-page. Among the original contributions we observe a description of an "Inflexible Suspension Truss for Bridges and Viaducts, by Mr. Hacket," and "Observations by the Editor on the late Discussion relative to the Atlantic Steam Navigation and Duty on Coals," to which are appended some remarks by Dr. Lardner, whose attention to this important subject is well known. There is also a useful mathematical paper, by Mr. Jones, of Liverpool, "On the Comparative Power of Locomotive Engines." These articles, with railway reports, and scientific and miscellaneous intelligence (chiefly gleanings from the late proceedings of the British Association), make up the present Number.

We extract from it the following account of a truly magnificent bridge across the Wear, now constructing on the Durham Junction Railway.

"The erection of the Durham Junction Bridge was commenced about twelve months ago, and is from designs by T. Elliot Harrison, Esq., the Stanhope and Tyne and Durham Junction Railway Company's engineer, who, so much to his credit, brought the works of this spirited proprietary to a satisfactory conclusion. The building of the bridge has been contracted for by Messrs. John Gibbs and Son, of Aberdeen, the gentlemen who constructed the bridge at Glasgow, and several other similar erections. The general style of the design is at once simple and grand, being elegant and imposing in appearance, without superfluous ornament. In this respect it harmonises admirably with the surrounding scenery, and will present a magnificent object in the landscape. The bridge has four principal arches, besides three smaller ones on each side, inserted in the approaches of wing walls to lighten the masonry, and add unity to the design.

"Of the four main arches, three are thrown over the valley, to obtain the requisite locomotive railway level; viz., one on the south side and two on the north side, the river Wear being entirely spanned by one splendid arch. The dimensions of the arches are as follows:—

"1. Over the valley on the south side, 100 feet span.
"2. Over the river Wear, 180 feet span.
"3. Over the valley on the north side, 144 feet span.
"4. Over the valley on the north side, 100 feet span.

"The length of the entire bridge is 810 feet 9 inches, and its width between the parapet walls 21 feet. Over the bridge a double line of railroad will be laid, there being on each side a flagged footway.

"But the extraordinary height of the bridge forms its most attractive feature. From the foundation of the main pier to the spring of the large arch, is 72 feet; from the spring to the crown of the arch, is 72 feet; and from the crown of the arch to the parapet wall, is 13 feet; making in all 157 feet. From this, to obtain the height for the ordinary water level, we must deduct that portion of solid masonry buried beneath the waves, which makes the observable walling 130 feet; this being (I speak from memory) about 20 feet higher than the justly-celebrated bridge of Sunderland.

"In the construction of this gigantic erection, no expense is spared. The stone, which is a hard, durable, well-coloured freestone, is obtained from Pensher quarry, situated about a mile south of the place, the property of the Marquis of Londonderry, and the outer quoins of the large arches will be composed of granite. The foundations both for the abutments and piers, are based upon solid rock, to obtain which advantage it was necessary, in some instances, to excavate to the depth of forty feet.

"The bridge is formed with turrets above the piers, which will add greatly to its strength transversely; the parapet walls will be very substantial, and care has been taken by Mr. Harrison, the able engineer, to make the erection not only safe, but durable."

Our previous remarks on the successive numbers which form the present volume, leave little room for further comment on a work of such acknowledged utility as the one before us.

EXTRACTS FROM FOREIGN SCIENTIFIC WORKS.

No. XVII.

ON THE MOTIONS OF THE EARTH AND ITS RELATION TO THE OTHER BODIES IN THE PLANETARY SYSTEM.

[From the *Traité de Geognosie.*]

The earth performs a revolution on its axis in 23 h. 56′ 4.1″, which, at the latitude of Paris, gives a velocity of 306 mètres* per second: that of a bullet, on issuing from the cannon, is 450 mètres.

The earth describes round the sun an almost circular ellipse—that body occupying the central point. The eccentricity of the curve is the 0.016814th part of the semi-conjugate axis, so that the two axes are to each other as 1 to 0.99986. The mean radius, or mean distance from the earth to the sun, is at least 23,577 radii of the earth, or 15,010,080 myriamètres; it is commonly estimated at 15,340,000.

The orbit is traversed in 365 days 5 h. 48′ 51″, which is the tropical year. But as the orbit retrogrades 50.1″ every year, the earth must pass over this arc, in order to reach the same point as in the year before; this requires 20′ 20″, and, consequently, the sideral year is 365 d. 6 h. 9′ 11″, which gives a velocity of about 9722 mètres, or 31,884 English feet per second. This retrograde motion is known under the designation of the procession of the equinoxes.

In the following table are stated the comparative relations of the earth to the other planetary bodies, according to the data supplied by Laplace and Delambre.

Planetary Bodies.	Diam.	Density.	Mass.	Distance from the Sun.	Eccentricity of Orbit.	Inclination of Orbit.	Sideral Revolution.	Velocity
Sun	111,74	0,24	339,630	0,	0,	0,	0,	0,
Mercury	0,38	2,88	0,171	0,39	0,206	7° 0′	0,24	1,61
Venus	0,96	1,05	0,92	0,72	0,007	3 23	0,65	1,17
Earth	1	1,	1,	1,	0,017	0 0	1,	1,
Mars	0,52	0,93	0,13	1,52	0,093	1 51	1,88	0,81
Vesta	....	....	....	2,36	0,183	7 7	3,66	0,65
Juno	....	....	....	2,67	0,254	13 4	4,36	0,61
Ceres	0,31	....	....	2,77	0,078	10 38	4,60	0,60
Pallas	0,15	....	....	2,77	0,245	34 37	4,60	0,60
Jupiter	10,86	0,24	309,	5,26	0,048	1 19	11,86	0,44
Saturn.....	9,98	0,096	93,	9,54	0,056	2 30	29,46	0,32
Herschel ..	4,33	0,021	1,69	19,18	0,047	0 46	84,02	0,22
Moon	0,273	0,072	0,0146	1,	....	5,	0,075	0,034

* A mètre is equal to 3 feet 11, 296 lines, French; and 100 metres equal to 109.32 yards English.

POMPEII.—The excavations of Pompeii have lately been prosecuted with much activity. Near the Street of the Tombs, there have been found in the vestibule of a house, four Mosaic pillars about fifteen feet high, in very good preservation. This is the first discovery of the kind, and if the interior of the house corresponds with this beginning, something valuable may be expected.—*German papers.*

PROCEEDINGS OF SCIENTIFIC MEETINGS.

MECHANICS' INSTITUTION, BIRMINGHAM.*

Mr. JUKES, in the commencement of his lectures, said, that in order to give those who had not before considered the subject some leading ideas by which to arrange the facts that may be presented to them, he would state three general propositions which contained the principal points established by modern Geologists:—

1st.—The Earth has existed as a planet for an immense series of ages, whose number is altogether unknown.

2nd.—The Earth has been continually modified by successive changes upon it and within it.

3rd.—The Earth has been inhabited by numerous races of animals and plants during successive periods, each race fitted to its peculiar period, and confined to it.

After explaining and enlarging upon these propositions, and showing the great practical importance of the latter to mining and other operations, and after obviating some objections which might be brought forward, Mr. Jukes went on to show that long periods of time are not adduced as necessary by geologists only, but that Astronomers also had established the necessity of long periods of either past or future time for the accomplishment of the numerous cycles wrought out by the motions of the heavenly bodies. He then entered into a brief explanation of the nebular theory of Sir J. Herschel, more especially as detailed by Professor Nichol in his "Architecture of the Heavens," in which it is supposed that the sun and all the visible stars are but a cluster bounded by the milky way, similar to those clusters of stars of which some of the nebulæ are shown to consist. That other nebulæ, which seem to consist merely of a dim fleecy light, and not to be resolvable into separate stars, may contain within themselves the germ of such a system, and may be, by condensation hereafter, transformed into suns and worlds. From these suppositions the hypothesis of central heat would be deduced. This hypothesis was shown to be rendered probable by the actual shape of the earth, and it was shown that it was adequate to explain existing phenomena. Other arguments were then adduced in favour of it, such as the heat of mines, &c. The actual relative position of the mineral masses composing the crust of the earth was then set forth, and it was shown that they were of two kinds—stratified and unstratified. Stratified rocks were shown to have been formed progressively, and were stated to have been divided by geologists into primary, secondary, and tertiary. It was then stated that they had been subject to convulsive movements, that by these their order was sometimes interrupted, but that that order was never inverted. The action of existing causes was stated to be producing similar effects. Geology was thus shown to be the history of the earth, which was best read, however, in an inverted order, by beginning with our own times, and then, guided by the clue thus obtained, tracing it back as far as our researches can go.

SECOND LECTURE.

Mr. JUKES said, that in this lecture he should enter upon the examination of the most recent period, beginning with the changes which have taken place in the historic times. We were mostly apt to suppose that no changes had taken place, from their extreme slowness, but a little consideration would show this to be impossible, since the elements which enter into the composition of the globe continually exert an active influence upon each other. There are two great agents of change—Water, and Fire or Heat, each acting in two ways, chemically and mechanically. The results of the chemical action of water were the depositions of matters it held in chemical solution, such as stalactites in caves, travertin from springs, of which an instance was given in the map half a mile broad and 200 feet thick, at San Vignone, in Tuscany, &c. The mechanical action of water was that which washed away earth from shores and rivers, of which instances were given in the river Niagara, which has cut a channel seven miles long and upwards of 100 feet deep by the action of its falls, and in the numerous deltas at the mouths of all rivers. The results of the chemical action of heat are necessarily obscured from our sight, but its mechanical action is exhibited in the volcano and the earthquake; a description was given of the tremendous eruption of Tomboro, in the Isle of Sumbawa, to show the magnitude of these forces, and numerous examples adduced of permanent alteration of level by the action of earthquakes, more especially the alternate elevation and depression of the Temple of Jupiter Serapis, near Naples. A similar action was then shown to have taken place before the historical era in the phenomena of raised beaches and submarine forests around many parts of our own coast; the fact of beaches containing sea-shells being found at considerable heights above the sea was then shown to be intimately connected with that of the gravel found in the interior of the country frequently containing the same shells, and a slight sketch was given of the different kinds of gravel found in this neighbourhood, and the places from which it was derived pointed out. Mr. Jukes then alluded to the organic remains found in the gravel, as the teeth and bones of the mammoth, the fossil elk, the mastodon, and megatherium; as also to the bone caves, as that of Kirkdale, in Yorkshire, &c., which was shown to have been a den of hyenas; and that of Gaylenreuth, in Saxony, to have been inhabited by an extinct species of bear, of enormous magnitude. The question was then entered into as to whether man was contemporaneous with these animals, and the whole of the evidence at present obtained shown to be in the negative. At all events, every argument was against his having existed before them in the numerous periods which geology shows to have preceded this, and the examination of which will be entered on in the next lecture.

THIRD LECTURE.

Mr. JUKES observed:—The march of operations by which the stratified rocks were formed, seems to have been the following. Take one of the great basins which were supposed to exist at first upon the surface of the earth, filled with a deep sea. This basin became gradually filled up with solid strata, deposited from the water. During this operation, disturbing forces were acting locally, modifying the outlines of the basin, and partially interrupting the formation of the strata. Now, the nearer this basin came to be filled up, the more apparent would be these interruptions, since the more easily would the land be lifted above the sea, and the deposition of new strata stopped. When the land was raised above the sea, or near enough to its surface to be within the influence of its tides and currents, periods of degradation would ensue, similar to those mentioned in the last lecture. Now it is a fact, that while the lowest or oldest stratified rocks, the primary and secondary, spread for the most part in broad sheets over large areas, the tertiary are more scattered, occurring in partial and distinct deposits, sometimes called basins, as if formed after the ocean had become divided into bays and gulfs and separate seas, by the elevation of various tracts of land above its surface. Hence arises a difficulty in classing the tertiary formations according to their age, since we frequently have not the direct evidence of superposition. There is, however, another principle by which we can arrive at this classification, which is, "that the newer a formation is, the more nearly allied are the remains of living creatures contained in it to those which exist at the present day." This principle has been applied by Mr. Lyell and M. Deshayes with success to the tertiary rocks. Mr. Lyell divides the tertiary rocks into three great classes, the Pliocene, Miocene, and Eocene. Tertiary rocks are those which contain the remains of any animal identical in species with those now living, or a recent species. Pliocene means the majority of a recent species, it is, therefore, that division which contains the newest or last formed rocks; Miocene, the minority of recent species; and Eocene, the dawn or first beginning of recent species, the earliest period when any living being existed on the globe that still remains on it. Pliocene is subdivided into older and newer. Newer Pliocene formations contain ninety or ninety-five per cent. of recent species, and are well developed in Sicily, where strata 1000 feet thick, some points of which are 3000 feet above the sea, exist, intermingled with beds of lava poured down from Etna, the gradual deposition of which is shown in one place by a bed of oysters twenty feet thick, resting on a bed of lava, and covered by other alternations of marine and volcanic beds; this occurs at Vizzini, twenty miles from the present sea. Older Pliocene rocks form hills called the Sub-Apennines, which flank the Apennines on either side, and are in some places upwards of 2000 feet thick, full of shells, about one-half of which belong to existing species. The crag of Norfolk and Suffolk likewise belongs to this period; it consists of beds of sand, clay, and soft limestone, extending a few miles inland, about eighty feet thick, full of shells, many of which are now found in the German Ocean; it has lately been divided by Mr. Charlesworth into the lower or coralline crag,

* We are indebted to our contemporary, the *Birmingham Advertiser*, for the following notice of the series of lectures delivered by Mr. Jukes, at this Institution.

* "I cannot lose the opportunity of recommending all persons who are interested in railroads to read this pamphlet; for, in addition to the most elaborate details, it contains a most popular and easy-to-be-understood illustration of the mechanical principles applicable to railways. (See 'An Account of the Liverpool and Manchester Railway, by Henry Booth, Esq.')"

and the upper or red crag, each containing certain genera peculiar to them, but nearly allied to each other in the time and manner of deposition. Beds belonging to the Miocene period are found in the basin of the Loire, in the Gironde, in Hungary, and Styria, and contain shells, about eighteen per cent. of which are recent; they are largely developed in many parts of the Continent, but do not occur in this country. The tertiary beds which were deposited during the Eocene period are chiefly exhibited in central France, in the Paris basin, and in the basins of London and Hampshire. Central France, during the Eocene period, was occupied by great fresh water lakes, among which were volcanic mountains in eruption. The lakes have left monuments of their existence in great deposits of marls, sandstones, and limestones, full of the remains of animals which inhabit fresh water, showing, very often, the very gradual process by which they were accumulaied, as do the foliated marls of the Limaque D'Auvergne, the minute laminations of which were caused by the continued deposition of the thin scales of the small animal called cypris. The basin of Paris is made up of strata partly marine and partly freshwater; it appears to have been a great bay, one end of which was kept fresh by the influx of a large river. The marine strata are full of shells, which are chiefly such as inhabit æstuaries. But the most remarkable organic remains are those extracted from the gypsum quarries of Montmatre, and re-constructed by the genius of Cuvier. These consist of numerous remains of land animals, some of which are extinct species of existing genera, but the most remarkable are those which belong to extinct genera of the order pachydamata. One of these, the palæotherium, was more nearly allied to a tapir than any other animal; there have been seven species of this animal discovered, varying from the size of a horse to that of a hare. Another is the anoplotherium, which was about the size of a wild boar, but allied in some respects to the otter, with a long and strong tail; it probably swam well, and frequented the lakes, from which it was washed down to the gulf, and buried where we now find it. The Eocene strata of our country are not so interesting as those of France; they consist chiefly of marine strata, except some freshwater beds in Hampshire and the Isle of Wight. These are the uppermost; below them occurs a thick bed of clay, called the London clay, resting upon a series of sand and clays, called the plastic clay formation; these have each been pierced to the depth of 500 feet, in forming wells. They occupy two great depressions in the chalk, the one called the London basin, and the other the Hampshire or Isle of Wight basin, and offer many remarkable phenomena as regards the distrubances which have affected them during and since their deposition, which could not be explained without the aid of diagrams.—The lecture concluded with a recapitulation of the evidence afforded by the tertiary strata, in support of the three propositions stated in the first lecture.

FOURTH LECTURE.

The subjects embraced in Mr. JUKES' fourth lecture being of great interest, we have pleasure in giving as full an abstract as our space will admit.

Mr. JUKES began by observing that the task assigned him for that evening was one of great magnitude, since he had to crowd into the compass of a single lecture matters which, if properly detailed, would occupy five or six. He had to go through the whole series of secondary rocks, the description of which had hitherto formed the chief bulk of the science of Geology. As it was impossible in such narrow limits to speak of the secondary rocks in general, he should confine himself to those of our own country, premising that no other country possessed so complete a series within so small an area, there being but one known formation of any importance belonging to the secondary class of rocks of which there is no representation in England. The method he should follow would be this; he should first describe the mineral character of the rocks, what kind of stuff each was made up of, and also the manner in which each was disposed, its outline and boundaries, and the position of the different strata with respect to each other; when he had thus proceeded from the top to the bottom of the series, he would then begin with the lowest, and examine the remains of living beings contained in it, and so on with the next above, till he arrived again at the highest. Two things would be learnt by this method: first, the actual position of the strata composing great portion of England, the solid geometry of the country; secondly, some knowledge would be gained of the natural history, and even of the geography of this portion of the globe, during the periods when those rocks were formed.—The highest secondary rock was the chalk, a soft limestone, divided into three portions: 1. The chalk containing rows of flints; 2. Chalk without flints; 3. Chalk [marl. This series rests on another, called the green sand, composed likewise of three divisions: 1. Upper green sand: 2. Galt, a stiff clay; 3. Lower green sand. These two formations, evidently nearly allied to each other from their organic remains, were classed together as the cretaceous system, which occupies a broad band of country running from Flamborough Head in Yorkshire, through Lincolnshire, Cambridgeshire, &c., right down the kingdom to the coast of Dorset. From the lower part of this main band it also sends out two spurs, one running through the north of Surrey and Kent, the other through the south of Surrey and Sussex. In that portion of the country the cretaceous system rested upon a class of rocks called the Wealden, which do not however extend universally beneath the chalk, but thin out towards the north and west, and would scarcely have been observed at all, but for a remarkable line of dislocation which has run nearly east and west through the south-east portion of the country, elevated the strata, and bent them into an arch, and the broken portions of the chalk, forming the crown of the arch have since been swept away, disclosing the inferior beds. The wealden strata admit of three divisions: 1. Weald clay; 2. Hastings sand; 3. Purbeck limestone; and appear, from their organic remains, to have been formed in fresh water. Below the cretaceous and wealden formations comes the oolitic system, chiefly an alternation of thick beds of clay and limestone, and occupying a wide tract of country, parallel to the main band of the cretaceous system, and on the western side of it. These two systems, as a whole, dip to the east, that is, each layer or broad sheet of which they are made up, slopes or hangs to the east; so that in walking from west to east, the stratum which you found at the surface in one place keeps getting deeper and deeper, till it is far below it at another; and in walking from east to west new beds are continually coming out to the surface from beneath those previously traversed; the exposed edges of the strata thus forming regular bands running side by side across the country. When, however, we get below the oolitic system of rocks, this regularity in a great measure ceases, and we find the next inferior rock, the New red sandstone, spreading out in wide plains over all the centre of the country, with the lower rocks coming out from beneath it in different places; the reason of which is, that before the deposition of the New red sandstone, the rocks of the carboniferous system which lie below it were affected by disturbing forces, broken up and contorted, and left in various positions and at various heights, with considerable irregularity; then the New red sandstone has been swept over them, filling up their hollows and depressions up to a certain level, and leaving the higher portions uncovered, which are now seen at the surface, frequently in unconnected patches—The carboniferous system is composed of three great divisions: 1. The coal measures; 2. The millstone grit; 3. The mountain limestone. These exist as three separate and distinct formations in all the country south of Durham and the north of Yorkshire; but in Durham and Northumberland seem blended together, so that beds of coal and grit are formed more or less in every portion of the carboniferous system there, from the top nearly to the bottom. Generally, however, in England and Wales, the coal is confined to the upper portion or true coal measures, which are alternations of shale, sandstone, coal, and ironstone; the middle portion it occupied by hard coarse grits, called the millstone grit formation; and the lower consists first of beds of shale and thin beds of hard fine limestone, several hundred feet thick, called the mountain or carboniferous limestone. In some coal-fields, however, as in those of Shropshire, South Staffordshire, and Warwickshire, the upper portion or true coal measures are found alone, there being neither millstone grit nor mountain limestone of any importance in these localities. Below the carboniferous system comes the Old red sandstone, a very variable formation, since in some places it either does not exist or is but a few feet thick, while in others, as in South Wales, it swells out to the enormous thickness of upwards of 10,000 feet—whole mountains, as the Beacons of Brecon, 3000 feet high, being composed of it.

The Lecturer then proceeded to trace the direction and amount of some of the great dislocations or faults which have affected the carboniferous ystem generally: but it would be impossible, without the aid of a map nd sections, to make this part of the lecture intelligible; suffice it to say, that in the north of the kingdom some strata which once existed in horizontal continuity have been rent asunder, and are now separated by upwards of 2000 feet of perpendicular distance.

Mr. Jukes then entered upon the other part of his subject, the organic remains, or remains of what had once been living beings, found in each of the secondary rocks, but this portion also requires the illustration of either specimens or drawings. He showed, however, that in the carboniferous system there are found innumerable remains of marine creatures entombed in the mountain limestone, and an equal number of the productions of the land or the inhabitants of fresh waters in the coal measures; that the shells and other things found in the mountain limestone differed entirely from those which exist at the present day; that some of them exhibited particular organizations, even unknown in the present animal kingdom, such as the spire contained within the shell of the spirifer. The plants of the coal measures, while they evidently show a tropical character, yet are in no case the same with any now known upon the globe, und many seem to have belonged to forms of vegetable life altogether strange to us. Again, when we come to the oolitic system, lying above the carboniferous, and separated from it by the new red sandstone, we find the skeletons of many reptiles and fish, and many sea shells, altogether new to us; the reptiles exhibiting characters unknown among existing beings, one of them more especially, called the pterodactyle, having had the faculty of flitting through the air like a bat; we also find plants again differing from the present, and not only so, but the animals and plants found in the oolitic system are entirely different as a group from those in the carboniferous, though more nearly allied to them than to existing races. The same thing is observable also in the wealden and cretaceous systems. Each great group of rocks contains a peculiar group of the remains of animals and plants differing from those found in the rocks above and below it. This difference is also evidently the result of a general law, since those rocks or groups of rocks which are nearest to each other in actual position in the series, are also most nearly allied in the organic remains which they contain, while in two rocks which are separated by a considerable interval, such as the mountain limestone and the chalk, for instance, although they are each limestones, the organic remains contained in them are absolutely and entirely different, not one species being common to the two, and many whole genera of shells or corals found in the one being altogether wanting in the other. From the facts thus detailed, (Mr. Jukes observed,) "no man in his senses can refuse to believe that many and great changes have taken place on the surface of the earth; that many races of living beings have inhabited it at different periods; while, for the elaboration of these operations, the lapse of great and perhaps immense periods of time is a necessary condition."

FIFTH LECTURE.

Mr. JUKES began by observing that he should adopt Professor Phillips's nomenclature, and call all the rocks which lay below the old red sandstone primary. He deprecated the use of the term Transition, as applied to the upper portion of these rocks, as tending only to give erroneous notions, that term having long survived the meaning in which it was originally used. The primary rocks have been hitherto but little known; but by the labours of Professor Sedgwick and Mr. Murchison they are now beginning to be better understood. Mr. Murchison has described the uppermost portion, to which he has given the name of the silurian system, and Professor Sedgwick the next inferior portion, under the name of the Cambrian system of rocks. The silurian system consists of four great groups of rocks, of which the first or uppermost are the Ludlow rocks—sandstones, limestones, and shales, characterised by certain organic remains, shells, madrepores, orthocera, &c., having a thickness of 600 feet. 2 .Wenlock and Dudley rocks—limestones, and shales, 600 feet, limestones occupying the upper part, characterised by numerous organic remains, madrepores, encrinites, shells, orthocera. trilobites, &c. Trilobites were crustaceous animals, that is, they belonged to the same class of animals to which lobsters, crabs, &c. belong. 3. Caradoc sandstone—sandstones and limestones, 800 feet; full of shells, encrinites, and trilobites, different from those in the other formations. 4. Llandilo flagstone, 400 feet, characterised by a peculiar species of trilobite. The silurian system occupies a broad band of country running from Pembrokeshire to the south of Shropshire, and thence through Montgomeryshire into Denbighshire. The three upper portions are well exhibited in a section carried through Wenlock Edge. Below the silurian system comes the Cambrian system of Professor Sedgwick, consisting of sandstones, slates, and some bands of limestone, in the first or Upper Cambrian rocks, and of slates and associated rocks, in the second or Lower Cambrian rocks, both being of very great but unascertained thickness. The first or Upper Cambrian rocks form the slate mountains of Cornwall and Devonshire, those of South Wales round Plinlimmon, those of the Lammermuir chain, and part of those of Cumberland and Westmoreland; they frequently contain abundance of organic remains. The second, or Lower Cambrian rocks, form the mountains of North Wales, the Snowdonian chain, and some of those of Cumberland; in Wales they contain some organic remains, in Cumberland none. Rocks belonging to one or other of these divisions of the Cambrian system occur at Dosthill, near Fazely, Hartshill, near Atherstone, and at Charnwood Forest, in Leicestershire. Below the Cambrian system there is found, in Cumberland, another group of slate rocks, called the Skiddaw slates, and in Scotland and other places are found rocks called mica slate and gneiss, of an immense thickness, and concerning which it is still a disputed point as to whether they were originally formed in their present state, or have been brought into it by the action of heat, which has modified them from their original condition.

Having now, in this and the two preceding lectures, given a very rapid sketch of the whole series of stratified rocks, Mr. Jukes observed, that it would be advantageous to employ some of the general ideas thus gained in the examination of a particular example, which was afforded us in our own immediate neighbourhood. The tract of country he would thus briefly describe extends from Rugeley nearly to Bromsgrove, with a breadth of about a dozen miles. The central portion of this tract is occupied by a coal-field, surrounded on every side by new red sandstone. The northern end of this tract is little known at present, but in the southern portion (of which a geologically coloured ordnance map was exhibited) were several most interesting and remarkable phenomena. A chain of hills runs nearly north and south, consisting of the Bromsgrove Lickey, Frankly Beeches, the hills east of Hales Owen, through the Leasowes, the Rowley hills, and those of Dudley and Sedgley, ending about one mile south of Wolverhampton. Along this line several different rocks were either brought up from beneath the coal measures, or the coal measures themselves were bent and elevated into a saddle. Beginning at the north end, and bringing our previously acquired knowledge to bear, we should find the Sedgley limestone to be the same with that of Aymestrey, from the evidence of its organic remains, and we should therefore know it to belong to the upper portion of the silurian system, or Ludlow rocks, and therefore to lie above the Dudley limestone, which comes out beyond it. It is very much broken and dislocated at Sedgley, so as to make a knowledge of its actual position difficult to be obtained in that locality. It has also been found beneath the coal measures near Wolverhampton, and is brought up again at the Hayes, near the Lye Waste. South-east of Sedgley we find three very remarkable hills, called Hurst Hill, the Wren's Nest, and Dudley Castle Hill, consisting of Wenlock and Dudley rocks, and offering by the very remarkable position of their strata several curious and interesting questions respecting the time and manner of their elevation; these rocks have been found also beneath the coal measures in one or two places between Dudley and Walsall, where they again come out and form the surface of the country for a considerable area; they appear to form the floor of the Bilston coal-field, the coal measures lying in a trough formed of these rocks. South of Dudley we find some considerable hills, called the Rowley Hills, consisting in their upper part of trap or basalt, and then the hills are formed for the most part either of coal measures or new red sandstone, till we come to the Bromsgrove Lickey. The quartz rock of which the Lickey is composed has lately been shown by Mr. Murchison to be nothing but Caradoc sandstone, altered by heat, since, in some parts, where the change has not been complete, casts of the characteristic shells are seen, and the limestones of this formation are found full of the same shells, in a good state of preservation, in some trial pits for coal near a farm-house called the Colmers. This, then, is the lowest rock we have in the neighbourhood, the third of the silurian system; and above that come the two other divisions, the Wenlock and Dudley rocks, and the Ludlow rocks, which we have seen to occur at Dudley and Sedgley. But here there is a great gap in the regular series, since between the silurian system and the coal measures there ought to come (if the series were regular) old red sandstone, mountain limestone, and millstone grit, to the thickness of many hundred feet at least, of which no trace is to be found in this coal-field. There has then been an interval between the formation of the Silurian rocks in this neighbourhood and the deposition of the coal upon them, sufficiently long to allow of the formation of old red sandstone 10,000 feet thick in South Wales, and of mountain limestone and millstone grit 1000 or 1200 feet thick in Derbyshire, Yorkshire, &c. What was the condition of this part of the country during the lapse of such an enormous period of time it is impossible to say; it existed as a small island perhaps, while all around was sea. At all events, after that period it shared with the surrounding country in the conditions (whatever they were) by which the coal measures were formed, and was probably covered with fresh or nearly fresh water till many hundred feet of alternations of shale, sandstone, coal, and ironstone were accumulated. During or just after this period volcanic forces were at work in this district, pouring forth streams of lava, and shaking and dislocating the previously formed strata, and injecting into them floods of melted rock, which having cooled slowly and under pressure, formed the trap rocks of Rowley, of Barrow Hill, of Powk Hill, and the beds of greenstone found associated with the coal measures in the Wolverhampton coal-field. The same forces have produced the great faults and numerous slips, breaks, and troubles, as they are called, which run in all directions through every portion of the field, and which cut it off around its boundaries, and depressing it, either by one great or several smaller downcasts, at last leave it buried out of our reach, beneath the surrounding beds of the new red sandstone, under which we do not certainly know at present how far it extends. The new red sandstone is the highest or newest stratified rock we have in the neighbourhood, but since its formation we know that enormous ages have elapsed, during which the successive formation of the oolitic and cretaceous systems, and of the tertiary rocks has been taking place in other countries. There are, however, some irregular accumulations found strewed over the surface, consisting of beds of gravel and great blocks of rounded stone. The gravel is formed of rounded water-worn pieces of stone, some of which have been derived from the Bromsgrove Lickey, others from the sandstones of the coal measures, from the Dudley limestone, and the chert of Derbyshire; as they still contain the shells or other fossils peculiar to those rocks, they have been produced probably by the action of a shallow sea or other water with numerous currents. The great blocks of rounded stone found lying upon this gravel, and on the surface generally, more especially around Wolverhampton, form part of the great northern drift, which has brought great blocks of granite, porphyry, &c., from the mountains of Cumberland, and strewed them over all the counties of Lancaster, Chester, Stafford, and Worcester, down to the Bristol Channel, marking probably the existence of an arm of the sea, separating Wales from the east of England, and having a strong current from the north. Since this period the whole country has been raised into its present situation, "fitted for the habitation of man, clothed with beauty to delight his eye, and enriched with mineral treasures to supply his every want."

SIXTH LECTURE.

In the previous lectures, mention had been made almost solely to Aqueous rocks, neglecting the Igneous rocks associated with them. From the examination of aqueous rocks, a geological chronology had been deduced; and the aqueous rocks were classified, not according to the substances of which they were composed, but according to their relative place in a series, or, in other words, according to the relative age or period of formation of each rock with respect to the others. Igneous rocks, however, do not admit of the same classification, since they have no definite order, and no internal marks by which to ascertain the period of their formation; they are then classed according to mineral character and composition. The chief minerals composing igneous rocks are felspar, hornblende, quartz, and mica, and out of the great variety of compound minerals formed by these and others, three may be selected by the geologist as types—lava, trap or basalt, and granite. Lava, composed chiefly of felspar, or horneblende, or allied minerals, might be either light and cindery, glassy, or hard, heavy, and compact, according to the different conditions of cooling. Trap or basalt may be said to be lava in its hardest and most compact state. Granite consists of quartz, felspar, and mica in separate crystals, but by the absence of sometimes one and sometimes another, and the gradual substitution of horneblende for mica, &c., granite passes through all the varieties of sienite porphyry, &c., into greenstone and basalt. Although there is no character in igneous rocks themselves by which to determine the period of their formation, this can frequently be done, either accurately or approximately, by the manner of their association with aqueous rocks, whose age is known. Thus we may examine igneous rocks in something like chronological order: first, those formed most recently; then those of the tertiary, secondary, and primary periods.

Existing volcanoes occur either in central isolated spots, or along lines. Central volcanoes are those of Iceland, Teneriffe, Isle of Bourbon, Madagascar, &c. Lines of volcanoes run through the Andes, the Stony Mountains, the Aleutian Islands, Japan, down the eastern coast of Asia, to Java and Sumatra. Volcanoes are of two kinds, subaeriel and submarine: those found in air consist of conical mounds of alternating ashes and streams of lava; in submarine volcanoes, the ashes, &c., would be swept away, and beds of lava would alternate with aqueous or stratified rocks, frequently made up of igneous materials. Examples of these two kinds were given in some of the eruptions of Hecla, and in the formation and destruction of a volcanic island off Sicily, called Graham's Island. Igneous rocks, formed during the tertiary period, are found in Central France, in Italy, near Bonn, and in Styria, and other places; and granite has been found protruded into tertiary rocks in the Andes, by Mr. Darwin. The volcanic mountains of Central France were briefly described. Igneous rocks, associated with secondary aqueous rocks, are found in the north of Ireland, where the great plateau of basalt, part of which forms the Giant's Causeway, overlies, and in some places cuts through the chalk, and has so affected it by intense heat, as to turn it into cyrstalline limestone. They are found also abundantly associated with the rocks of the carboniferous system throughout England, of which an instance may be seen in the trap rocks of the Rowley hills, and other places in the neighbouring coal-field. A brief account was then given of the experiments of Gregory Watt upon Rowley Rag, which have since been repeated by some gentlemen of the Philosophical Institution, throwing the greatest light upon the origin of the jointed and columnar structure igneous rocks, and more especially basalt, so frequently assume. The more frequent occurrence of igneous rocks with those of the primary period is a necessary circumstance, since the primary, being the lowest stratified rocks, must be always first invaded by igneous rocks, which are invarisbly injected upwards from the interior of the earth. Granite is frequently found among primary rocks, dislocating and upheaving them, and sometimes sending veins and dykes among them, which must have been injected while fluid into their cracks and crevices. Many hypotheses have been framed to account for volcanic phenomena, among others, that of Sir H. Davy is most worthy of mention, which refers them to heat evolved by admission of oxygen to unoxidised metals; but the mere presence of fiery spots, and patches, and veins of igneous rocks upon the globe, is not the sole thing to be accounted for. Every tract of ground over the known earth must at one time or other have been beneath water, since rocks deposited by water, many thousand feet thick, everywhere exist; and the mighty and universal agency which has raised whole continents from the bed of the sea, and reared mountain chains thousands of feet high, is too intimately connected with that which has caused the pressure of igneous rocks among them, to allow of their being very different. Now the sole hypothesis which assigns a cause adequate to the elaboration of these mighty operations, is that which supposes the earth to have an intense interior heat. Mr. Jukes then went into some other arguments to prove the great interior heat of the globe, and concluded his lecture by briefly summing up the evidence which established the three propositions with which he set out, that the earth had existed for a great but unknown length of time, that a continued series of changes had been always taking place upon it, and that numerous races of living beings had successively inhabited it.

GEOLOGY.—Mr. Johnston, Lecturer on Chemistry in the Durham University, is at present delivering a course of lectures on geology in the Philosophical Hall, at Leeds, with great eclat.

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